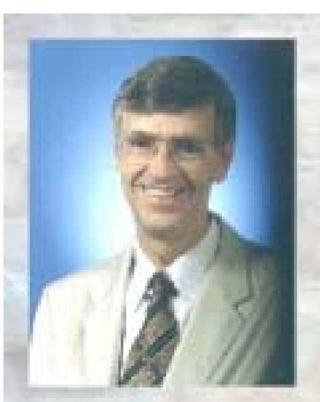
Maryland Water Resources Research Center

Department of Civil & Environmental Engineering
University of Maryland
College Park, Maryland 20742

Spring 2005 Allen P. Davis, Director Phil Kearney Associate Director

2004 Wastewater Treatment Plant Conference

The Center held its third annual conference on *Wastewater Treatment Plants and the Chesapeake Bay: Processes and Problems,* October 22, 2004. Margaret Brent Room, Stamp Student Union Building University of Maryland, College Park, MD. This year's conference was coponsored by Maryland Water Resources Research Center and the Maryland Sea Grant College. Five invited speakers addressed the following topics:
An Overview of Municipal Wastewater Treatment in Maryland. Eric Seagren Civil and Environmental Engineering, University of Maryland
Endocrine Disrupters in Municipal Wastewater Discharges. Alba Torrents, Civil and Environmental Engineering, University of Maryland
A New Look at Dechlorination. George Helz, Chemistry and Biochemistry, University of Maryland
Nutrient Discharges.



Dr.Clifford Randall

Implications of the Flush Tax on Sewage Plants – Clyde Wilber Greeley&Hanson

Here are some of the important points raised by the various speakers:

- There has been a profound failure to implement nitrogen removal at wastewater treatment plants during the life of the Chesapeake Bay Program,
- Flush tax revenues will not begin to cover the costs of upgrading the 66 major wastewater treatment plants
- One pound phosphorus can produce 111 pounds of algae biomass.
- Current dechlorination methods never completely destroy chloramines, which pose a threat to aquatic organisms.
- Dechlorination with thiosulfate or metallic iron could diminish the threat from chloramines
- Metabolites of endocrine disrupters are being detected downstream from major watewater treatment plants

In This Newsletter

Former WRRC Director, George Helz, Retires

Prof. George R. Helz, Director of the Maryland Water Resources Research Center from 1990 to 2001, retired from the University of Maryland in December 2004. A Maryland native, George arrived at the University as an assistant professor in 1970 after training at Princeton (A.B., Geology) and the Pennsylvania State University (Ph.D., Geochemistry).

In 1970, people in the United States were newly aware of the continent-wide danger posed to wildlife by certain products of chemical industry. The Chemistry Department's visionary chairman, Joseph Vanderslice, became convinced that chemistry students needed to learn how the environment works, so that similar mistakes would be avoided in the future. George was one of several interdisciplinary scientists whom Vanderslice recruited to set up a novel research and education program in environmental chemistry. This program has thrived, sending out more than 100 Ph.D. graduates with specialization in environmental chemistry. George, who is the last of the original faculty group to leave the University's active service, advised a third of these students. Today, chemistry departments at many research universities are developing programs similar to Maryland's.

From its meager beginning in 1970, the University of Maryland's commitment to environmental science has grown immensely. George played a leading role in this growth. He was active in the inception and early development of the Maryland Sea Grant College, the Graduate Program in Marine Estuarine Environmental Sciences (MEES) and the Graduate Program in Toxicology (now centered at UMAB). For more than a decade he represented the University as a Trustee of the Chesapeake Research Consortium. During his tenure as Director of the Water Resources Research Center, he developed and coordinated an innovative graduate program in groundwater chemistry and hydrology. This program drew on faculty from five departments at College Park and received substantial support from the National Science Foundation.

In his research, George has tackled a range of environmental problems. He has long been interested in hazards to aquatic wildlife associated with discharging chlorinated water to rivers and estuaries. His group was one of the first to describe chlorine's unique chemical behavior in saltwater. They have developed new analytical methods for oxidative chlorine by-products, and have used these to discover a class of chloramines that resist standard dechlorination treatments. They have determined the chemical mechanisms that make these chloramines resistant and have designed better treatment methods.

His group's early mapping of Chesapeake Bay's sediment composition and deposition rates has established a framework for much subsequent research by others. Through fundamental research on the sedimentary chemistry of molybdenum, George and his students have produced a method for reconstructing the history of "dead zones" in coastal waters. Historical reconstruction is a necessary step in identifying the causes of this growing global problem.

Over the last decade, George and his students have made many measurements of chemical properties that control the mobility of troublesome elements, like mercury and arsenic, in anaerobic groundwater. They were among the first to employ synchrotron-based x-ray spectroscopy to study environmentally relevant aqueous speciation problems.

In addition to regularly teaching freshman or sophomore chemistry, George has for many years taught introductory environmental chemistry to seniors and first-year graduate students. His course often attracted students from outside the chemistry department. It was cited in *Chemical and Engineering News* in 1994 as a model for an advanced course in its subject. During the 1980's and 1990's, George also offered a well-regarded graduate course in Marine Geochemistry for MEES students. In 2001, George was recognized as a Distinguished Scholar Teacher for his multifaceted contributions to education in the environmental sciences at College Park.

George plans to continue his research activities at a diminished level for the next several years. His current NSF grant runs for another year. He is collaborating with Stanford colleagues, who have recently received funding for a large amount of beamtime at the Stanford Synchrotron Research Laboratory. He is under active consideration for a Fulbright Fellowship to do research at the Rudjer Boskovic Institute in Zagreb during 2005-2006. He continues as an Associate Editor of *Geochimica et Cosmochimica Acta,* and he chairs Scientific

Advisory Committees of environmental research institutes at both Ohio State and Stanford.

NATIONAL COMPETITIVE GRANTS PROGRAM
REQUEST FOR PROPOSALS
FY 2005

The U.S. Geological Survey in cooperation with the National Institutes for Water Resources requests proposals for matching grants to support research on the topics of water supply and water availability, which are issues of importance nationwide. Proposals are sought in not only the physical dimensions of supply and demand, but also quality trends in raw water supplies, the role of economics and institutions in water supply and demand, institutional arrangements for tracking and reporting water supply and availability, and institutional arrangements for coping with extreme hydrologic conditions. For planning purposes, the amount available for research under this program is estimated to be $1,000,000 in federal funds, though there has not been a FY 2005 appropriation of funds for this program as of the date of this Announcement. Any investigator at an institution of higher learning in the United States is eligible to apply for a grant through a Water Research Institute or Center established under the provisions of the Water Resources Research Act of 1984, as amended. Proposals involving substantial collaboration between the USGS and university scientists are encouraged. Proposals may be for projects of 1 to 3 years in duration and may request up to $250,000 in federal funds. Successful applicants must match each dollar of the federal grant with one dollar from non-federal sources. Proposals must be filed on the Internet at https://niwr.org/ by 5:00 PM, Eastern Standard Time, February 22, 2005 and must be approved for submission to the National Competitive Grants Program not later than 5:00 PM, Eastern Standard Time, March 4, 2005 by the Institute or Center through which they were submitted. The Government's obligation under this program is contingent upon the availability of appropriated funds.

2005 FUNDED PROPOSALS

The Center funded three proposals and a Summer Student Intern with 2005 funds. Here are abstracts of those funded proposals.

Theoretical and Experimental Evaluation of Acetate Thresholds as a Monitoring Tool for in situ Bioremediation Jennifer G. Becker, Department of Biological Resources Engineering, University of Maryland

In situ bioremediation approaches offer great potential for cost-effective clean-up of environmental contamination. However, demonstrating the success of in situ bioremediation can be challenging due to the heterogeneous, dynamic, and inaccessible nature of the subsurface. The consumption of electron acceptors during bioremediation of hydrocarbons and other contaminants can result in shifts in the predominant terminal electron-accepting processes (TEAPs), which may be useful for monitoring. Because traditional assessment tools have disadvantages, an accurate indicator of TEAPs is still needed. Using an integrated experimental and modeling approach, this study will systematically test the hypothesis that characteristic ranges of acetate thresholds may exist for different TEAPs and, therefore, acetate concentrations may be useful for monitoring bioremediation. Acetate thresholds established by pure microbial cultures that utilize acetate as an electron donor and different TEAPs will be measured experimentally using batch laboratory systems. The importance of kinetic and thermodynamic factors in controlling acetate thresholds will be evaluated using a mechanistic mathematical model. Model parameters will be obtained by fitting the model to the experimental data. The usefulness of acetate thresholds as indicators of bioremediation will be evaluated by measuring acetate concentrations in contaminated sediments and comparing measured values to model-predicted concentrations.

<u>Fingerprinting Sediment to Determine Sources in an Urban Watershed</u> Brian Needelman, Department of Natural Resources Sciences & Landscape Architecture, University of Maryland

The Anacostia River drains northern Washington D.C. and adjacent portions of Maryland; the river is degraded by sediment, biological, and organic contaminants. The Anacostia drains to the Chesapeake Bay, which is adversely affected by excess sediments and associated nutrients. Submerged aquatic vegetation (SAV) has declined drastically over the past 30 years in the Bay due to degraded water clarity associated with fine-grained suspended sediment and eutrophication. Knowledge of the sources of this sediment is essential in any effort to restore the Anacostia River and the Chesapeake Bay.

Understanding how urbanization impacts the natural processes of erosion and sediment delivery is important to understanding sediment problems in fresh waters and estuaries. In addition, many contaminants common to urban areas have a propensity to attach to and be transported by fine-grained sediments. Few studies have examined sediment sources or transport in urbanized areas. We propose to identify and quantify the source type of fine-grained suspended sediments in the North East Branch of the Anacostia using the sediment fingerprinting technique. Fingerprint components will include nutrients, metals, mineralogy and radionuclides. We will use a statistical model to determine the statistical significance each fingerprint has in identifying sediment sources. A multivariate mixing model will be employed to determine the relative contribution and location of each source type contributing to the suspended sediments. A soil survey will be completed in the North East Branch of the Anacostia to assist in the identification of sediment source locations. Knowledge of the location of sediment sources and its relation to land use and soil distribution will allow science-based management practices to target zones at high risk for sediment loss.

<u>Chemical and Biological Availability of Zinc in Road Runoff Entering Stormwater Retention Ponds</u> Ryan E. Casey, Department of Chemistry, Towson University

Highway runoff has the potential to negatively impact receiving systems due to transport of contaminants that accumulate on road surfaces. Recent work from the USGS has shown that tire wear particles constitute a significant source of Zn to the environment, with release inventories similar to waste incineration; during 1999 approximately 10,000 tons of Zn were released to roadways in the U.S.
This study will quantify the amount and distribution of Zn in a stormwater retention pond receiving highway runoff. Because these ponds serve as habitat for a variety of species, the chemical and biological availability of Zn to biota is integral to assessing the habitat quality of retention ponds. This study will relate the amount and speciation of Zn in the retention pond to Zn inputs through highway-derived runoff events. The proposed work will also relate the chemical speciation and availability of particulate Zn to the bioavailability and toxicity of Zn to pond organisms (larval amphibians).

This project will involve characterization of the Zn distribution and speciation in pond sediments, surface soils and roadway particulate matter collected around this site. The use of sequential extraction procedures will allow us to quantify the fractions of Zn found in the solid phase and predict their availability to organisms in this receiving system. In addition, we will quantify the actual loading of Zn in the aqueous and particulate phases during storm runoff. By sampling water and discharge of runoff into the pond, we will determine both the magnitude and temporal characteristics of Zn loading (e.g. first-flush effect). We will also evaluate the biological implications of roadway runoff contamination of sediments in this system. We will conduct bioassays with larval amphibians to quantify effects of exposure to retention pond sediments. We will also conduct an assay that will determine the relevant routes of exposure (contaminated sediment vs. contaminated periphyton diet) in this system.

2005 Summer Student Project

Utilization of High Carbon Content Fly Ash as a Reactive Medium during the Remediation of NAPLs from Subsurface Waters M. Mlih Demirkan Department of Civil &Environmental Engineering, University of Maryland

The objective of study is to investigate the fundamental factors affecting the behavior of a reactive barrier incorporated with fly ash. The re-use of high carbon Class F fly ash has a potential for minimizing the movement of organic chemicals found in the soil and the groundwater. Preliminary analysis indicated that the fly ash from the Brandon Shores Plant located in Baltimore has a significant amount of sorption capacity for naphthalene. During the experimental work we will take the advantage of high carbon content and small particle size characteristics of cyclone-produced Class F fly ash. These properties can be advantageous in remediation of soils originally polluted with petroleum-based contaminants (e.g. naphthalene, o-xylene). Two major testing techniques will be employed; (1) Batch-scale adsorption tests will be conducted to determine adsorption capacity of high carbon content Maryland fly ashes. (2) Column adsorption tests will also be examined to ensure the scale effect of batch tests to field applications and to evaluate the transport parameters for a possible reactive barrier design.

Featured Scientist

Dr. Brian Needelman
Department of Natural Resource Sciences and Landscape Architecture

Dr. Needelman an assistant professor of soil science in the Department of Natural Resource Sciences and Landscape Architecture. His specializations are pedology (the study of soils as natural bodies) and geospatial analysis. He came to the University of Maryland in 2002 after completing my Ph.D. at Penn State on mechanisms of runoff generation. His adviser was a hydrologist (Bil Gburek at USDA-ARS).

Needelman currently teachs three courses, Soil Morphology, Genesis and Classification He exposes students to the breadth of soils found on earth and the major processes of soil formation. GIS Applications in Soil Science is a course that covers the basics of ESRI ArcGIS, soil survey as a geospatial database, and spatial statistics. Besides teaching a field soil morphology course and he is coach of the University of Maryland Soil Judging team in alternate years. Students write a qualitative description of a soil (in a pit), estimate the genetic history of the soil, interpret it for various uses, and classify it. Soil Judging is a wonderful opportunity for students to learn in the field

His major research project is on drainage ditches in Somerset County, Maryland. These drainage ditches are vibrant ecosystems with many characteristics of wetlands, yet are direct conduits from agroecosystems to rivers and the Chesapeake Bay. Initial interest was the transport and fate of phosphorus and nitrogen in ditches. This study has grown to include organic matter, sulfides, heavy metals, and ditch biology. A graduate student, Robert Vaughan, has collected data revealing that soil formation is occurring in drainage ditches. Vaughan may be the first to study drainage ditch sediments as soil bodies. One unexpected observation found was the presence of sulfides in the drainage ditch soils; these sulfides oxidize to sulfuric acid leading to pH levels as low as 2.5 in some incubated samples. A second graduate student on this project, David Ruppert, is

beginning a study of the roles of organic matter in these soils and waters. This project is a collaboration between the University of Maryland College Park, the University of Maryland Eastern Shore, the Maryland Department of Natural Resources, and the USDA-ARS Pasture Systems and Watershed Management Unit in University Park, PA.

MWRRC is funding a new project on sediment fingerprinting to identify sediment sources in the Northeast Branch of the Anacostia watershed, which will be the research project of Olivia Devereux, a new graduate student. Allen Gellis from the USGS, Jerry Ritchie from the USDA-ARS in Beltsville, and Karen Prestegaard from the UMD Department of Geology are collaborating on this project. A long-term research goal is to work in urban landscapes, in particular the Anacostia watershed.

Much of the geospatial analysis research is on soil mapping and phosphorus distributions in soils. Mitchell Scott, graduate student, is currently working on the mapping and characterization of the Marlboro Clay formation in Prince George's County. The distribution and variation of this formation is important to county planners because it is problematic for building and has a high landslide potential.

Lastly, research is underway in the area of four-dimensional visualization and modeling of soil landscapes. A high resolution elevation data set will be used to georeference video imagery of a soil landscape. This will be integrated with a biogeochemical process model to visualize processes operating in drainage ditches during a flow event.