WRRI NEWS
Water Resources Research Institute
of The University of North Carolina
www.ncsu.edu/wrri
ISSN 0549-799X
Number 350 January–February 2005

Water Infrastructure: The Replacement Era

by Carla Burgess, freelance writer

The public is becoming acutely aware of ever-stricter standards for treating drinking water and wastewater in the United States. They see it in headlines and on the evening news. Some citizens know about more stringent standards because of moratoriums on new development in their communities; some existing treatment systems aren't even in compliance with current regulations. In farm communities, the changes are evident in the new ways animal waste must be stored and disposed of. And coastal residents are painstakingly aware of how wastewater discharge and runoff affects rivers and estuaries.

Most anyone paying attention knows that water infrastructure is the lifeline though which new residents and businesses are served. It's a non-negotiable that fuels the local economy while it safeguards public health and sustains quality of life. Much less obvious to the public is the nature of critical underground infrastructure—the pipes and related conduits that bring water to the tap and take wastewater out of the house and the workplace. Most people would be surprised to know that in some places this buried infrastructure has been successfully doing its job, inconspicuously, for more than 100 years. We didn't build it, we didn't pay for it and we rarely think about it. And, experts say, we're about to get a rude awakening.

Public water systems, municipal managers and other players in the clean water arena are preparing, with eyes wide open, for what the American Water Works Association (AWWA) has dubbed "the dawn of the replacement era." Our nation's older systems were installed during boom times—the turn of the century, the 1920s, post WWII. Even the most recent infrastructure is old enough to be stressed or failing. Whether the infrastructure is made of clay, concrete, iron, or steel, older systems are nearing the end of their functional life; even some of the youngest systems are showing their age. The useful life of treatment plants is typically 20 to 50 years. Pipes can last from 15 to more than 100 years, depending on soil conditions, materials used (newer not necessarily meaning better), climate (including the rate of incidences of hurricanes and other disastrous weather) and capacity.

The crumbling condition of the nation's water and sewer systems earned both types of treatment infrastructure a grade of "D" on the American Society of Civil Engineers' 2001 Report Card for America's Infrastructure. The diminishing federal role in financing these infrastructure needs contributed to the assessment.

Several recent studies and reports predict a vast chasm between the amount of money being spent to renovate infrastructure and the capital, operation, and maintenance needs over the next 20 to 30 years. By some estimates, this gap could be as much as $600 billion if water and sewer treatment systems don't direct more resources toward maintenance, repair and replacement. The U.S. Environmental Protection Agency analyzed the nation's 16,024 publicly owned wastewater treatment plants and 54,000 community drinking water systems. Assuming that the current level of spending remains the same, the EPA reports a $271 billion total gap between the current level of investment and needed investments for sewer infrastructure by 2019 ($148 billion representing operation and maintenance). The agency predicts a $263 billion gap for drinking water infrastructure spending during the same time period ($161 billion for operation and maintenance spending). The Water Infrastructure Network (WIN), AWWA and similar organizations are also sounding the alarm.

As bad as the situation looks, forecasters say it's not too late to change the

continued on page 5

In this issue **January–February 2005**

Director's Forum

WRRI Conference, April 4 & 5

Gregory D. Jennings, Interim Director, Water Resources Research Institute

The theme of the WRRI Annual Conference scheduled for April 5, 2005, at the McKimmon Center in Raleigh, is "Managing Water Quality & Quantity: Integrating Science, Technology & Policy." Since the WRRI was established in 1964, it has facilitated research and education addressing all aspects of water resources, ranging from the basic sciences to engineering, economics, and public policy. Many outstanding researchers at North Carolina's Universities and government agencies have contributed to the great wealth of knowledge we have about the state's water resources. The challenge we all face is to integrate our understanding of water sciences, technologies, and policies into effective management programs to protect water quality and availability. Participants will interact with other water resource professionals in discussing how they can apply research outcomes to create successful management programs.

We are very pleased to have Bill Holman as the keynote speaker for this year's WRRI Conference. Bill is Executive Director of the North Carolina Clean Water Management Trust Fund which provides grants to local governments, state agencies and conservation non profits to help finance projects that specifically address water pollution problems. In many ways this program is unique to our state in applying funding to meet high priority water resource protection needs. We look forward to hearing from Bill as he draws from two decades of experience working with North Carolina's natural resource policies.

This year's conference will include more than 70 oral and poster presentations from University, government, and industry professionals. Sessions will focus on urban watersheds, bacterial contamination, estuarine resources, nonpoint source controls, and water supply planning, among many other topics. The breadth and quality of the abstracts submitted for presentation demonstrate the capabilities of the professional water resource community in North Carolina. Participants will learn from and be challenged by the presenters to work toward better understanding and protection of water resources in our state.

Our Preconference Symposium this year will focus on "Low Impact Development (LID) Approaches for Sustainable Water Management" with speakers addressing the technologies and policies for promoting LID in North Carolina. As we look to the future with predictions of our state population doubling in the next three decades, we must ask how we can protect water supplies while continuing to grow. LID is an idea that must be examined for application in planning, design, construction, and long term stormwater management.

The mission of WRRI supports providing opportunities for technology transfer and idea exchange through conferences, workshops, seminars, newsletters, email, and the web site. Please let us know if you have ideas for enhancing WRRI outreach programs.

ISSN 0549-799X
Number 350
January–February 2005
Published bimonthly

This newsletter is financed in part by the Department of the Interior, U.S. Geological Survey, as authorized by the Water Resources Research Act of 1984. Forty-three hundred copies of this newsletter were printed at a cost of $1,524 or 36 cents per copy.

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February action of the Environmental Management Commission

At its regular meeting on February 10, 2005, the EMC took the following action:

- ❑ Approved to amend concentrations for 33 of the current Groundwater Quality Standards in 15A NCAC 2L .0202. The action on fluoride was deferred and will come back to the Groundwater Committee for further consideration. The reason for the amendment to 15A NCAC 2L .0202, Groundwater Quality Standards, is the result of a triennial review of Groundwater Quality Standards pursuant to 15A NCAC 2l .0202(f). The proposed rule changes are being made to incorporate the most updated health information and concentration levels as Groundwater Quality Standards in 15A NCAC 2l .0202.
- ❑ Approved amendments to prevention of significant deterioration (15A NCAC 2D .0530) and new source review rules (15A NCAC 2D .0531). These rules are being amended to bring them in line with the federal rules by incorporating recent amendments to 40 CFR 51.165, Nonattainment New Source Review and 40 CFR 51.166, Prevention of Significant Deterioration of Air Quality.
- ❑ Approved to hold a public hearing to receive comments on Environmental Impact Statement (EIS) and petition for interbasin transfer by the Cities of Concord and Kannapolis. The EMC is responsible for Interbasin Transfer (IBT) certifications and the associated public hearing according to NC General Statutes 143-215.221. The public hearing will meet public comment requirement for both the petition for the transfer and the support EIS. When the public hearing is started the EIS would also go to the NC Clearinghouse where it would be distributed to state agencies.
- ❑ Approved to proceed to public hearing on amendments to air quality rules pertaining to two definition rules (15A NCAC 2A .0101 and 2Q .0103); change of address rules (15A NCAC 2D .0103, .1905 and 2Q .0105); an incinerator rule (15A NCAC 2D .1201); open burning rules (15A NCAC 2D .1902, .1903, .1904, and .1906); permitting rules (15A NCAC 2Q .0101, .0103, .0301, .0304, and .0305); a permit exemption rule (15A NCAC 2Q .0102); the title V permitting rule (15A NCAC 2Q .0523); and the air toxic modification rule (15A NCAC 2Q .0706).
- ❑ Adopted to uphold the Administrative Law Judge's decision for the 401 Water Quality Certification issued to the Piedmont Triad Airport by DWQ. This was in connection with the expansion project to construct a new runway, relocate roadways, and develop a proposed air cargo hub facility to be leased by Federal Express Corporation. Petitioners challenged the decision of the Director of DWQ to issue Piedmont Triad Airport the 401 Certification.
- ❑ Adopted to uphold the Administrative Law Judge's decision in the case of Joseph Henson versus DENR, Div. of Air Quality, DAQ 2004-015. The total penalty and investigation costs were $1,275.00.

More information is available at the EMC web site: http://h2o.enr.state.nc.us/admin/emc/

DENR launches new stormwater web site

The goal of the site is to educate North Carolina residents, local government officials and businesses about stormwater and polluted runoff - the largest single contributor to water pollution in North Carolina. The web site is an "umbrella" of sorts in that it pulls data from all DENR divisions that deal with stormwater and presents it one place. The site also links to research, guidance, technical assistance and public education tools from other states.

Please take the time to explore ncstormwater.org. DENR's Office of Environmental Education teamed up with Creative Services to create a Pollution Solution Workbook suitable for children (http://www.ncstormwater.org/pages/workbook_main.html). The site's Toolkit area http://www.ncstormwater.org/pages/toolkit.html assists Phase II communities conduct the public education, outreach and participation required by the federal government.

On the technical assistance page (http://www.ncstormwater.org/pages/technicalassist.html), businesses can find guidance on best management practices for stormwater that are customized by industry. Some of these documents are also available in Spanish (http://www.ncstormwater.org/pages/techassistance_bmps_spanish.html.)

If you have feedback or questions please direct them to Chrystal Bartlett, DENR's Stormwater Awareness & Outreach Coordinator at chrystal.bartlett@ncmail.net or (919) 715-4116.

Water Infrastructure *continued*

outcome. Indeed, the EPA's predicted spending-versus-needs gaps shrink significantly if investments were to increase by 3 percent per year, which is over and above the rate of inflation and also accommodates estimates of long-term economic growth. The EPA's "revenue growth scenario" closes the gap to $31 billion for sewer infrastructure and $45 billion for drinking water. Even so, the burden cannot be realistically accommodated through ratepayers opening their pocketbooks a little wider. To close the gap by rate increases alone, customers would have to pay more than double for water and sewer service, WIN estimates, and lower- and middle-income families would be unduly encumbered.

The federal government continues to raise standards under the Clean Water Act and the Safe Water Drinking Act, but many of the mandates are underfunded or unfunded. For example, the Clean Water State Revolving Fund is a federal program that offers low-interest loans for local infrastructure projects (including efforts to control raw sewage overflows, rehabilitate aging plants, and reduce stormwater runoff). But even as the states' needs grow, and as the months tick off of the EPA's multibillion-dollar gap analysis clock, Congress cut the fund by 15 percent last year, from $1.35 billion to $1.1 billion. The federal contribution to water and sewer infrastructure pales beside its commitment to roads, bridges, and airports.

The NC Rural Economic Development Center (also known as the Rural Center) projects statewide water and sewer infrastructure needs of $7 billion in the next five years and $15 billion by 2030. Much of these needs exist in small towns and communities that are often ill-equipped to finance system improvements. A big disadvantage is economy of scale—fewer customers support each system. Rural communities have a smaller economic base and a higher percentage of low-income residents, for whom even small increases in utility rates can be crippling. When utility rates spike, these customers often shave the household budget for medicine, prenatal care, or food.

Nearly 75 percent of the state's residents are served by small water systems (by definition serving fewer than 3,300 people), compared to 10 percent nationally, according to the Rural Center. Some 300 rural and economically depressed communities received $240 million in grants from a bond issue approved by North Carolina voters in 1998. The funds helped with the building and repair of infrastructure. (Intrusion of groundwater and stormwater into sewage pipes is one of the most problematic and pressing wastewater issues in the state, creating stress on systems and contributing to sewage overflows.) Rural communities have hung on through the aid of these funds, but the pot will be fully emptied in February 2005, and their future options are limited. Smaller communities are more likely to lack "creditworthiness"; many have poor bond ratings and are ineligible for private loans to finance system improvements. Borrowers who do qualify pay higher interest rates for private capital.

A large customer base served by predominately small systems is not unique to North Carolina. Seventy-one percent of the nation's publicly owned wastewater treatment plants serve populations of fewer than 10,000 people. Ninety-three percent of all community water systems (which by definition serve more than 25 people per day year-round) in the country serve fewer then 10,000 people; about 43 percent of these systems are publicly owned.

As small systems in North Carolina revamp their aging water infrastructure, the issue of parity is one of the most troubling.

"What is a fair share for a resident to pay for water?" says Jean Crews-Klein,

continued on page 5

vice president of business and natural resources for the Rural Center. "We have not had that discussion as a state. We need to understand where poverty is and where median housing incomes have slipped."

In systems both large and small, the needs for routine replacement of worn-out infrastructure components will compete for dollars required to upgrade facilities to comply with new regulatory standards under the Safe Drinking Water Act and Clean Water Act. Compounding that burden are the more-recent regulatory requirements for managing and dispatching stormwater.

Certainly a running dialogue on infrastructure reinvestment will be key to avoiding a crisis in the coming decades. The EPA report identified a litany of research needs, including economic analysis of demographic shifts; analysis of which components of a system should receive priority attention due to age, condition, and importance; and development of more efficient, effective, and affordable technologies. The report recommends an inventory of the nation's infrastructure and its condition. Already ahead of that game, North Carolina was the first state to conduct an in-depth inventory and assessment of its water and sewer systems (659 in 75 counties) and produce a comprehensive standardized information base (incorporating GIS) as part of a joint initiative of the Rural Center and the N.C. Rural Development Council. The initiative will continue to refine and expand the statewide database.

Valuable information about water and sewer infrastructure replacement needs can be found in ***Clean Water: Our Livelihood, Our Life*** *(1998, Rural Center);* ***The Clean Water and Drinking Water Infrastructure Gap Analysis*** *(2002, EPA),* ***Dawn of the Replacement Era: Reinvesting in Drinking Water Infrastructure*** *(2001, AWWA), and* ***Clean and Safe Water for the 21st Century: A Renewed National Commitment to Water and Wastewater Infrastructure (WIN)****. These publications can be easily located and downloaded on the Web. The ASCE (http://www.asce.org/reportcard/2005/) will issue a new Report Card for America's Infrastructure March 9.*

Best tasting water found in Rocky Mount

For many years, the City of Rocky Mount has boasted of the quality of its drinking water from the Rocky Mount water system. Last November, the City of Rocky Mount brought home from the North Carolina American Water Works Association and Water Environment Association a statewide honor for aesthetic quality when its drinking water was voted the State's Best Tasting Water. Runner-up to Rocky Mount was the City of Greensboro and the City of Raleigh finished in third place.

The contest included samples of drinking water from 23 communities across the state. Six judges evaluated the taste of each of the samples using an unbiased testing method with samples identified only by letter.

Ensuring the quality of City public drinking water is no small task and it must meet rigid analytic standards and also meet the taste test of its customers. The City of Rocky Mount changed its treatment process in February 2003 to reduce the levels of certain by-products of chlorination. The change to chloramination helped to ensure Rocky Mount continued to supply water customers with safe and aesthetically pleasing water. For most customers, the noticeable change was an improvement in the taste and odor of City drinking water. With chloramination, the chlorine smell and taste is less apparent.

Jay VanHoose, Water Treatment Plant Superintendent, said, "This award and the improved taste of City water can be attributed to the capital funding that allowed the changes in the City's water treatment process."

More information at:
http://www.ci.rocky-mount.nc.us/cnic.html

In Memoriam
Harold Edward "Ted" Mew, Jr.

Dr. Harold Edward "Ted" Mew, Jr., Senior Hydrogeologist of the Groundwater Planning Unit, Division of Water Quality, N.C. Department of Environment and Natural Resources, passed away February, 16, 2005.

Mew was a graduate of the University of Denver from which he received undergraduate and master degrees in Civil Engineering. He received a PhD in Environmental Engineering and Water Resources from Duke University in 1996. He was a registered Professional Engineer in North Carolina.

Devoted to protecting the environment, Mew spent his career at DENR focused on hydrogeologic and groundwater research and authored numerous professional papers. He was also a lifetime member of the Sierra Club and an active member of the Umstead Coalition.

People

Terry Rolan, director of Durham's Department of Water Management, has been selected by his peers to lead the American Water Works Association (AWWA). He will be the first president of AWWA from the North Carolina Section since it was formed in 1921. Rolan will be installed as president-elect in June at the AWWA's Annual Conference and Exposition in San Francisco, California and will begin a one-year term as president of AWWA in June 2006. Rolan serves on the Advisory Committee for WRRI.
More information:
http://www.ci/durham.nc.us/news/

Pam Smith, retired after more than 15 years of service at North Carolina State University. Smith has served as senior writer/editor for the North Carolina Sea Grant since November 1999. She has written for *Coastwatch* magazine, handled media relations and edited newsletters and other special products.

WRRI-sponsored research reported

The principal investigator on a WRRI-sponsored research project may fulfill the obligation of providing a final project completion report by submitting a refereed journal publication that meets specific criteria (see policy at http://www.ncsu.edu/reports/guidelines/policy.html). The journal articles summarized below have been accepted as a final completion report under the new policy. A limited number of reprints of the full journal articles are available from WRRI. Send requests to WRRI at water_resources@ncsu.edu or call 919-515-2815.

Consequences of Hypoxia on Estuarine Ecosystem Function: Energy Diversion from Consumers to Microbes

Daniel Baird, University of Port Elizabeth; Robert R. Christian, East Carolina University; Charles H. Petersen and Galen A. Johnson, UNC-CH Institute of Marine Sciences.

Ecological Applications 14(3): 805-822, 2004

This refereed journal article has been accepted as the final technical completion report for WRRI project 50267, "Contribution to Long-Term Modeling Tier of the Neuse River and Estuary as Functional Assessment of Environmental Phenomena through Network Analysis," Robert R. Christian, East Carolina University. It has been designated WRRI-2004-JA8.

The Neuse River estuary is one of the most highly stressed by nutrient loading. Excess nutrient loading through human activity on land can lead to eutrophication in the estuaries and coastal ocean areas which produces algal blooms, oxygen depletion on bottom waters, and fish kills.

The authors assembled a great amount of data to test how energy and carbon transfers and systems processes are influenced by seasonal hypoxia—characterized by low levels of dissolved oxygen that increases with growing eutrophication—in the Neuse River estuarine ecosystem. The authors employed network analysis (quantitative food-web models that describe the biotic flows of an ecosystem) to:

- ❑ demonstrate how a water quality problem, such as eutrophication-driven hypoxia, cascades through the ecosystem to affect energy and materials flows to higher trophic levels
- ❑ explain the potential significance of stability and sustainability of the food web.

Persistent hypoxia now routinely develops during summer in the mesohaline portion of the Neuse River estuary—from Minnesott Beach to the mouth of the river where it joins the Pamlico Sound (salinity range of 5-18 ppt)—as in other eutrophied estuaries and coastal embayments.

The trophic structure of the Neuse estuary now resembles the generic pattern for a degraded temperate estuary with:

- ❑ intense planktonic algal blooms and similarly high production of free-living bacteria
- ❑ trivial levels of abundance of rooted aquatic plants and benthic macroalgae
- ❑ depleted apex predators, and
- ❑ functional extinction of the historically dominant benthic grazer, eastern oysters.

Large differences were shown between the summers of 1997 and 1998 in trophic transfers and system dynamics. Total biomass of heterotrophs declined over summer by 51 percent in 1997 as compared to only 17 percent in 1998, mainly due to a greater mortality of benthic invertebrates from more intense hypoxia. Since the net primary production increased over summer and herbivory was mainly benthic, the herbivore consumption of primary production decreased by 35 percent in 1997 and by 29 percent in 1998. Increases in energy demand by demersal fishes of 380 percent in 1997 and 507 percent in 1998 were seen due to an influx of juvenile fishes and their rapid growth in the estuarine nursery over summer. These findings show the hypoxia-enhanced diversion of energy flows into microbial pathways from consumers and mass mortality of benthic invertebrates from bottom hypoxia occurred at the season of greatest demand by predatory fishes and crabs using the estuary as a nursery.

The authors calculated the trophic efficiency values for the Neuse River estuary. They were lower at ~4 percent as compared to 9.6 percent for the mesohaline Chesapeake Bay; 6.4 percent for the Ythan estuary in Scotland, 12.5 percent for the Ems-Dollard estuary in the Netherlands, and 6 percent for the Kromme estuary in South Africa. The authors conclude that trophic efficiency summarizes the ability of the ecosystem to transfer its production to higher trophic levels, where ecosystem goods and services of value are located. Conservation, restoration, and management of estuarine ecosystems should reflect the possibility that without controls on eutrophication and restoration of oysters and other benthic grazers, the high levels of microbialization of the Neuse may represent the future of estuaries worldwide.

Note: Also see the WRRI Report No. 343-E, ***Monitoring and Modeling of the Neuse River Estuary, Phase 2: Functional Assessment of Environmental Phenomena Through Network Analysis***. See summary in WRRI NEWS, Number 347, May/June 2004 issue.

From the Archives

A Word About the Water Resources Research Institute

The establishment of the Institute within the Consolidated University of North Carolina was announced by Governor Dan Moore and President William C. Friday last October. Governor Moore referred to the Institute as an important new arm of the State's efforts to increase and protect North Carolina's water resources. President Friday called attention to the scope of the Institute as a University-wide enterprise that can make maximum use of the University talents for focusing upon the critically important water resource. He also said the organization of the Institute represents an effort to meet a pressing State need, as well as a new concept in University organization and administration.

The Water Resources Research Institute was established to promote a multidisciplinary attack on water problems, to develop and support research in response to the needs of the State, to encourage the development of balanced and complete educational programs in water resources, to coordinate research and educational programs with water resources and to provide a link between the State and Federal water resource agencies and related interests in the University. All research projects supported by the Institute will be planned and conducted by the University in cooperation with the State agencies and in close coordination with Federal agencies working in allied areas.

Research and educational activities of the Institute will be conducted through and in support of existing departments and schools of the University. This modus operandi will be furthered by the Institute Technical Committee representing departments with water resources interests and responsibilities and through personal contacts between the Institute Director and members of the faculty. The same concept of cooperative activity will extend to relationships with State and Federal agencies through the members of the Institute Advisory Committee and others having common interests in the State's water resources.

One of the unique characteristics of the Institute is its ability to cross-institutional lines and to provide a center of coordination and information for water resource activities and needs. Open channels of communication between investigators, departments, schools, campuses, organizations and State and Federal agencies dealing with North Carolina's water resource problems is essential to real progress and to the efficient use of funds made available for this work. The exchange of ideas is considered to be one of the important functions of the Institute and will be realized through any and all means available, including personal and group discussion, conferences, seminars, correspondence and a newsletter.

This is the first issue of a monthly newsletter from the Water Resources Research Institute of the University of North Carolina. Every effort will be made to develop this into a genuinely useful medium for North Carolinians working in the field of water resources. Anyone having information of interest to others may send it to the Institute for inclusion in the Newsletter.

Editor's Note: This article was written for the first issue of the WRRI News, February 1966. Dr. David H. Howells served as the first WRRI Director from 1965 to 1976.

A Look Back

This picture, taken August 24, 1972, is of an urban conservation tour in Baltimore, Maryland showing how stream bank erosion on Chinquapin Run was consuming park land (upstream view from bridge). The field tour attire of white buttondown shirts and slacks was much more formal than that of polo shirts and jeans worn today.

(Credit: USDA-Soil Conservation Service – now NRCS). From a print in the WRRI photo collection.

13th National Nonpoint Source Monitoring Workshop

From Projects to Programs: Enhancing States' NPS Management Programs through Lessons Learned from NPS Monitoring Projects

September 19-22, 2005
Sheraton Capital Center Hotel
Raleigh, NC

The 13th year of this workshop will once again bring together land managers and water quality specialists to share information on the effectiveness of best management practices in improving water quality, effective monitoring techniques, and statistical analysis of watershed data. The workshop will focus on the successes of Section 319 National Monitoring Program projects as well as other monitoring projects from throughout the United States.

More information:
http://www.ncsu.edu/waterquality/nmp_conf/

NCWRA
North Carolina Water Resources Association

Monday, September 13
"Pathogens Gut Check:
What's in Your Water?"

Monday, December 5
"If You Build It, Will They Come?:
Cumulative and Secondary Environmental Impacts Evaluated as Required by SEPA, NEPA, and Environmental Permits–
Will They Affect Local Growth Options?"

All luncheons begin at 11:30 AM and are held at the Jane S. McKimmon Center at NC State University, Raleigh, NC.

Updates to this schedule will be posted to:
http://www.ncsu.edu/wrri/events/ncwra/

Become a member of NCWRA. For more information contact WRRI at (919) 515-2815 or visit the NCWRA web site at http://www.ncsu.edu/ncwra/.

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