

Virginia Water Central

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No matter what kind of gauge one uses, spring rain in Virginia was below normal. For precipitation data over the past several months, please see the Water Status Report, page 15. *Photos:* Traditional-style rain gauge (top) and automatic-recording gauge (bottom) at Virginia Tech's Kentland Farm, May 2, 2006.

FEATURE ARTICLE

Flood Hazard Mitigation from a Grundy, Virginia, Perspective

By Amanda Mullins

For many, the terrible devastation caused by Hurricanes Katrina and Rita along the Gulf Coast in August 2005 has been almost unbelievable. Unfortunately, images of displaced citizens, destroyed homes, and piles of rubble serve as a harsh reminder that this nightmare really occurred. Now, as the Gulf Coast slowly recovers, citizens, government officials, scientists, engineers, planners, and others are trying to determine how to avoid such destruction in the inevitable future natural disasters. In New Orleans, for example, questions range from "Should stronger levees be built?" to "Should New Orleans even be rebuilt in such a dangerous location?"

Like New Orleans, many other communities across the nation have had to face the terrible effects of natural disasters and search for solutions to prevent future destruction. When

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plagued by floods, hurricanes, or other recurring disasters, communities have developed varied solutions to their problems. Some areas, like New Orleans, have come to rely on dams, levees, floodwalls, and the like that seek to manage or control a natural resource. Other localities have chosen activities that seek to reduce the potential damage from a natural disaster, such as not rebuilding in flood-prone areas or instituting new building regulations in earthquake zones.

Actions designed to reduce risks from disasters are called **mitigation** actions. According to the Federal Emergency Management Agency (FEMA), hazard mitigation is “any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards.”¹

One way of describing mitigation activities is to distinguish between **project** and **process** activities. In a 2005 study, the Multihazard Mitigation Council (MMC) of the National Institute of Building Sciences defined these terms as follows:

“project” mitigations...include physical measures to avoid or reduce damage from disasters (such as elevating, acquiring, or relocating structures...and “process” mitigations...include activities that lead to policies [and] practices...that reduce risk and loss (e.g., assessing vulnerability and risk, educating decision-makers, and fostering adoption of strong building codes).²

The MMC study documented a variety of mitigation activities used by communities. For example, Multnomah County, Oregon—facing dangerous landslides from severe storms—acquired various properties in the affected area, including a school, and eventually demolished them. Freeport, New York, a community plagued by recurrent floods, elevated streets located in the floodplain, instituted an early-warning system, and held various events to raise public awareness about hazard-mitigation measures and

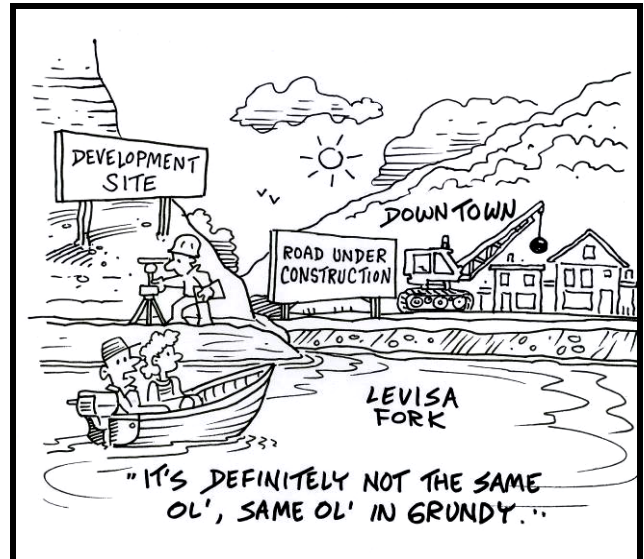
¹ Federal Emergency Management Agency (FEMA), *State and Local Mitigation Planning How-To Guide – Getting Started: Building Support for Mitigation Planning* (2002), p. 7; www.fema.gov/plan/mitplanning/howto1.shtm (as of 6/12/06).

² Multihazard Mitigation Council of the National Institute of Building Sciences, *Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings From Mitigation Activities*, (Dec. 2005), Vol. 2, p. 4; www.nibs.org/MMC/mmcactiv5.html (as of 6/12/06).

preparedness. Tuscola County, Michigan, also plagued by flooding, enacted strict floodplain regulations and building codes to accompany a project to redirect stormwater.

The study also illustrated that mitigation efforts can have significant economic benefits. In the mitigation projects considered by the MMC study, an average of four dollars in future societal losses were saved for every dollar a community spent on mitigation activities.³

Flood mitigation activities are especially important, for every year floods cause dozens of fatalities along with property damages costing hundreds of millions of dollars. Flood-prone communities face a crucial question: should they attempt to keep floodwaters away from people, or should they move people away from floodwaters? In southwestern Virginia, the **town of Grundy** is watching, experiencing, and evaluating the results of *their* answer to that question.



The Grundy Flood Control Project⁴

Grundy, a small, Appalachian town (2000 Census population 1,100) located in extreme southwestern Virginia, offers an instructive, local case study for hazard mitigation, because Grundy’s solution to a recurring flooding problem combined both project and process mitigation activities.

³ *Ibid.*, Vol. 1, p. 5.

⁴ Unless otherwise stated, the source for information in this section, including quotes, dates, figures, and assigned duties, is the U.S. Army Corps of Engineers from personal communication with Grundy Project Manager John Bock in April 2006 and Corps-provided information accessed on 3/15/06 at www.sullivan-county.com/identity/grundy.htm.

Grundy's location is rather precarious, nestled in a small valley surrounded by steep mountains with two streams, Slate Creek and the Levisa Fork of the Big Sandy River, running directly through the middle of town. Both streams frequently flood, threatening the town's businesses and homes with muddy floodwaters. In fact, since 1929, Grundy has experienced nine major floods. According to the *Virginia Mountaineer*, Grundy's local newspaper, a 1984 flood caused \$4 million in damages and the legendary 1977 flood caused three deaths and \$15 million in damages.⁵ The 1977 flood, memorialized by Grundy residents in songs and stories, largely prompted the mitigation project underway there today.

In 1981, after seeing the damages several major floods inflicted on some Appalachian towns, Congress passed the Water and Energy Appropriations Act, which required the U.S. Army Corps of Engineers (the Corps) to evaluate flooding in the Appalachian region and to develop flood-protection plans for five communities in the area, including Grundy. For about six years, the Corps, in conjunction with town representatives, considered dams, levees, and other flood-control structures as solutions to Grundy's flooding problem. Because such structures were very expensive and would have had significant construction and environmental impacts while providing only partial protection, the Corps and the town discarded them as potential solutions and began to consider **nonstructural alternatives**, which are measures that attempt to reduce flood damages "without significantly altering the nature or extent of flooding."⁶ Nonstructural alternatives include, among other things, floodplain zoning, flood warning systems, emergency evacuation plans, floodproofing of endangered buildings, and the removal of structures from hazardous areas. (Note that some nonstructural alternatives could be considered "project" activities, while others are "process" activities, according to the definitions given in the previous section.)

In 1989, a task force made up of representatives from both the town and the Corps and headed by the late Mr. Ron King, a Grundy

attorney, met for the first time to consider potential nonstructural solutions to Grundy's flooding problem. Eventually, the task force developed an interesting idea: Rather than floodproofing certain buildings or moving only one or two structures out of the flood plain, why not move the entire flood-prone business section of the town? Though this initial plan had many components, it essentially called for the demolition of most downtown buildings located in the flood plain and the redevelopment of a new downtown in an adjacent area situated safely above the 1977 flood level.

But this plan was too expensive for the Town of Grundy. The federal 1986 Water Resources Development Act required a non-federal sponsor to shoulder 25 percent of the costs for this type of project, and the locality would have been required to contribute about \$25 million, a prohibitive price for the small town.

The task force reached a solution, however, when then-Virginia Delegate Don McGlathlin and U.S. Rep. Rick Boucher (D-Va., 9th District) suggested that the Corps, Grundy, and the Virginia Department of Transportation (VDOT) work together on the project. VDOT, which was seeking to improve U.S. Route 460, had already received approval to build a new by-pass around the town. After several meetings, VDOT, the Corps, and the town concluded that collaboration among the federal, state, and local government would not only make the project possible (by solving the funds-match problem, as explained below) but also would also save each partner millions of dollars. As a result, the three entities began development of a Project Cooperation Agreement. In the 1996 Water Resources Development Act, Congress authorized the revised plan, and in 1998, the Corps, the town, and VDOT signed the Agreement.

According to Chuck Crabtree, Grundy's current town manager, without VDOT's involvement, the Corps would have been responsible for \$200 to \$300 million for the project, with Grundy contributing 25 percent of those costs. Now, the Corps expects to spend roughly \$100 million for the entire project because VDOT, rather than the Corps, is responsible for acquiring right-of-ways as well as building a highway embankment that will also function as a levee. Moreover, according to Mr. Crabtree VDOT's road improvement would have cost the state between \$150 and \$160 million; by cooperating with the Corps and the town, however, VDOT's estimated costs for the road improvement are considerably lower—between

⁵ Cathy St. Clair, "Federal, State, Local Officials Celebrate Historic Groundbreaking," *The Virginia Mountaineer*, November 2, 2000.

⁶ U.S. Army Corps of Engineers, Planning Guidance Notebook, (ER 1105-2-100), April 2000, p. 3-10; www.usace.army.mil/inet/usace-docs/eng-regs/er1105-2-100/ (as of 6/12/06).

\$70 and \$80 million. The savings come from VDOT not having to bypass the downtown, but building the new road directly through the downtown area that is to be relocated. Because VDOT handles property acquisition for the project, VDOT functions as the needed non-federal sponsor, providing the required 25-percent match and covering Grundy's share.

To accomplish the project, each partner was given specific tasks. The Corps was given the monumental job of preparing the redevelopment site—a mountain located across the Levisa Fork (please see photos to the right). Ground was officially broken on this large-scale project in October 2000. According to *The Appalachian Voice*, the Corps removed roughly 2.3 million cubic yards of dirt to create about 13 acres of flat land.⁷ This portion of the project was completed in January 2005, and, according to Mr. Crabtree, the area now covers about 130,000 square feet, roughly double the size of the original downtown business section.

The Corps' duties also included relocating Grundy's police and fire stations, acquiring and flood proofing (on a voluntary basis) certain homes and businesses located below 1977 flood levels (please see photo to the right), and constructing a **ringwall** (a flood control measure designed to prevent flood waters from reaching protected areas) that would protect several buildings not being moved, including the historic Buchanan County Courthouse.

As of April 2006, the Corps had finished the redevelopment site, relocated the town's fire station, and was to begin construction of the ringwall soon; the voluntary floodproofing activities have been occurring since the project began. In November 2005, another \$8.8 million in Congressional funds were appropriated to the Corps for the construction of this ringwall as well as floodproofing for individual homes, bringing the total federal investment so far to about \$85 million.⁸

Turning to VDOT's part of the project, asbestos abatement and demolition of buildings along U.S. Route 460 was to begin by June 2006, with roadway construction to start soon

Continued next page



March 2004 aerial view of Grundy redevelopment site across the Levisa Fork from downtown Grundy. (Photo courtesy of the Army Corps' of Engineers Huntington District Web site, www.lrh.usace.army.mil/projects/current/, as of 6/12/06.)



March 2006 view from the current downtown location across the Levisa Fork to the new development site. (Photo by Amanda Mullins.)



House elevation in Grundy as part of the town's flood-protection project. (Photo from *Virginia Mountaineer*, September 1, 2005, reprinted with permission.)

⁷ Tonia Moxley, "Grundy, Va. Picks Up and Moves To Higher Ground," *Appalachian Voice*, June 1, 2002.

⁸ Office of U. S. Rep. Rick Boucher, Press Release, 11/9/05, www.house.gov/apps/list/press/va09_boucher/grundyfcrp05.html (as of 6/12/06).

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thereafter.⁹ VDOT plans to reconstruct 2.6 miles of U.S. 460, in three phases. The first phase beginning is a 0.7-mile portion of the new road located along the Levisa Fork atop the highway embankment. This embankment will be about eight feet higher than the original highway, and, because it will function as a levee, will provide flood protection for those downtown buildings *not* being removed. Also, VDOT was charged with relocating some buildings as well as acquiring the various properties for the road improvement. VDOT plans to spend roughly \$35 million on acquiring right-of-ways for the new section of U.S. 460 and another \$24.2 million on the first phase of the road's actual construction.¹⁰

Finally, the Town of Grundy, using private funding and various grants, was tasked with developing the new business district that will be located on the redevelopment site. Redevelopment activities have been occurring roughly since the physical project began. For example, the town's Industrial Development Authority has already brought several new businesses into the town, including a Comfort Inn and a Huddle House, and the Town has also leased parts of the redevelopment site to a private developer, who will also work to bring other new businesses to the area.

A new Wal-Mart store will be the center of this new downtown. Like the project, the Wal-Mart will be unusual, with a location atop a multi-level parking structure; this unique design, the first multi-level Wal-Mart ever built, was initially intended for Los Angeles, California, but Grundy got the store instead.¹¹ Ultimately, this store will use 100,000 of the redevelopment site's 140,000 square feet; other businesses, including local and new businesses, will make use of the remaining 40,000 square feet.¹² According to one news report, the firm responsible for building this new store plans to invest more than \$20 million in its construction, and roughly a dozen stores and

restaurants will eventually join Wal-Mart at the location.¹³

One additional requirement for the Town was to continue its participation in the National Flood Insurance Program (NFIP), not just for the relocated section for any flood-prone sections, according to Mr. Crabtree. Grundy has been a participant in this program since 1987. Some 20,000 communities across the nation participate in the NFIP, and, as participants, must "adopt and enforce floodplain management ordinances to reduce future flood damage. In exchange, the NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in [the] communities."¹⁴

Impacts and Effects

This project has changed Grundy in many ways and on many levels. By project's end, Grundy will have a new downtown. The downtown area along the Levisa Fork will be protected by the highway embankment, while the area closer to Slate Creek will be protected by a ringwall. According to *The Virginia Mountaineer*, the new area will retain its "downtown" feel with several design features, including patterned sidewalks, plaza paving, landscaping, decorative light poles and fixtures, and buildings of modular faced brick, synthetic stone, and colored mortars.¹⁵ Moreover, because Grundy partnered in 1999 with Rebuild America, a federal program that encourages energy efficiency, it has the chance to make sure the new town is more energy-efficient.¹⁶

The town has also changed economically. According to Town Manager Crabtree, there were 12 active businesses in the downtown area before the project began. Some of these business owners were still paying off FEMA loans they received after the 1977 flood, and others were unable to sell or lease their businesses because of the buildings' location in the floodplain.¹⁷ Many downtown buildings were simply empty structures. Once the project began, however, all this changed. All businesses in the affected area

⁹ Va. Dept. Transportation (VDOT), "Route 460 Grundy Floodproofing Project," www.virginiadot.org/projects/const-project.asp?ID=108 (as of 6/12/06)

¹⁰ Conrad Hill, VDOT representative, personal communication 4/24/06. For more information, please see the VDOT 2006-2011 Six-Year Improvement Plan, which includes the Grundy project, available at www.virginiadot.org/projects/syp-default.asp (as of 6/12/06).

¹¹ Cathy St. Clair, "Town, Developer Seal Wal-Mart Deal." *The Virginia Mountaineer*, October 7, 2004.

¹² Ibid.

¹³ Kathy Still, "Bridge to the Future: Grundy Span's Completion Paves Way for Next Phase," *Bristol Herald Courier*, April 26, 2005.

¹⁴ FEMA, "The National Flood Insurance Program," www.fema.gov/plan/prevent/floodplain/ (as of 6/12/06).

¹⁵ Lauralee Jackson, "Rebuild America Partnership Forged," *The Virginia Mountaineer*, January 4, 2001.

¹⁶ Ibid.

¹⁷ Moxley, *Appalachian Voice*, June 1, 2002.

were required to move. Some business owners chose to close or retire rather than move, while others relocated to different locations in the town, including the Grundy Plaza, a renovated shell building. Now, all the downtown buildings are empty, and once they are torn down, the town will look—and *be*—completely different.

The project has also helped attract new businesses to the area, including a new restaurant and several new stores, and according to Mr. Crabtree, there are now more new businesses than in the original downtown. Located in various places throughout Grundy, including the Grundy Plaza, these businesses provide jobs and needed tax revenues for the small town; as a result, some residents believe the town's future is bright.

During interviews conducted by the author in April 2006, however, other residents revealed that they are not so optimistic and have several concerns about the project. For example, some residents who believe that flood control was necessary would have preferred other flood-control options, such as re-channeling the river or moving the town to a site that would not have required such major construction. Some people thought the project is just too expensive. The current location of various businesses was a chief concern for one relocated business owner, who felt that the Grundy Plaza is not conducive to retail businesses because it is more like an office building than a mall. Another relocated business owner was concerned that a new Wal-Mart will put small, local stores out of business. That owner, moreover, feeling that plans had changed frequently, was unsure that local businesses would really be able to relocate to the new site once it is completed.

One Resident's Reflections

This project has impacted the town physically, economically, and psychologically. The most obvious impacts have been (or will be) physical: the town's relocation, the floodproofing of various buildings, and the eventual construction of the new highway and floodwall. Using both flood-control structures (namely the highway embankment/levee and the floodwall) as well as a mix of "process" and "project" mitigation activities, the Corps, VDOT, and the town have made downtown Grundy a safer place to live and do business. Downtown businesses have been moved to areas above the 1977 flood levels, a move that will prevent future flood damages and the expensive economic recovery and the potential loss of life such damages always entail. Moreover,

those buildings and homes not being moved will be better protected. Economically, new businesses and the jobs they provide have given Grundy an economic boost, and, in the end, such economic changes give some residents hope for a new beginning. Others, however, are worried that new businesses will force local owners to close their doors.

Grundy's story has much in common with other situations where communities are searching for ways to prevent damages from recurrent natural disasters like floods or hurricanes. Like Grundy, these communities must ask certain basic questions, such as "Who will fund the project?" or "Who will be involved?" What is more, communities should consider each solution's time frame for implementation. For example, solutions for Grundy's flood problem were being developed in the 1980s, but actual construction has only occurred in recent years. Also, communities must consider whether flood-control structures, various mitigation activities, or—as in Grundy—a mixture of both are the best and most affordable solution to their problems.

Often, answers to these questions are community specific. For example, for Grundy the distinctive partnership among all three levels of government was crucial, because it generated the necessary non-federal match and saved all three partners money. The combination of Grundy's flood-control structures with various mitigation activities is also notable. What is more, this project has provided the small town with an opportunity to attract new, large businesses that many residents believe will eventually change, for good or ill, the face of Grundy forever; without the project, such an opportunity likely would never have presented itself.

As a lifetime resident of Grundy, I have watched this project unfold over the past several years, and I have mixed emotions about it. On one hand, I am glad the Town, the Corps, and VDOT decided to move the flood-prone downtown rather than re-channel the river or build a dam upstream, for I know such drastic structural measures cause severe environmental damage and can eventually lose their effectiveness as rivers change course or dams collect sediment.

For these reasons, in my opinion, the project's end result will be worth its expense. I am also glad the redevelopment project has provided residents with new job opportunities and boosted the local economy. Like many college students, I face the tough choice after graduation of returning home or moving on to a new community. Unfortunately, I will likely not be able to return

home because there are so few job opportunities for me in Grundy. I hope this project will help change this, if not for me, at least for those children now attending the local schools.

But, like many other residents, I am concerned about this project's impact on the "soul" of my home. As one of my high school classmates once said, I do not want Grundy to become just another exit off of U.S. Route 460, and I am afraid a Wal-Mart will do just this—make my home into one of a million other "interstate towns" across the nation. More importantly, I cannot help but wonder if those local businesses, whose owners I know by name, will be able to keep their heads above water—economically, that is—as more and more chain businesses arrive.

I think many would agree that this project is not what we expected; I know I never thought a Wal-Mart would come to my hometown. Change, however, is inevitable, and, like everyone else, I am watching and waiting. Now, whenever I drive past those empty, boarded-up storefronts waiting to be torn down, I have hope those changes will be for the better.

Overall, the nature of the project, from its funding to its partnership to its effects on the town, is exceptional and remarkable. Grundy's example teaches that residents in areas prone to natural disasters need not consider only traditional solutions, but instead should think creatively and search for ways to tailor a solution to their own unique situation, just as Grundy has done. But Grundy's story also shows that any solution takes time and will probably change a community in many ways, some completely unexpected.

Other Floodplain Relocation Stories

Other communities have participated in projects to relocate structures out of a floodplain. The following reports provide information on such efforts:

U.S. Tennessee Valley Authority. *Town of Clinchport, Virginia, Floodplain Relocation Project*. Knoxville, Tenn.: TVA Office of Community Development; 1979. 110 pages.

Moser, David A. *Assessment of the Economic Benefits from Flood Damage Mitigation by Relocation and Evacuation* (Res. Rep. 85-R-1). Fort Belvoir, Virginia: U.S. Dept. of Defense, Army Corps of Engineers, Engineer Institute for Water Resources; 1985. 67 pages.

Becker, William S. *Come Rain, Come Shine: A Case Study of a Floodplain Relocation Project at Soldiers Grove, Wisconsin*. Madison, Wisc.: Wisconsin Dept. of Natural Resources, Bureau of Water Regulation and Zoning; 1983. 55 pages.

These references were courteously provided by Wanda Headley, Library Manager for the Natural Hazards Center at the University of Colorado.

Amanda Mullins, a rising senior at Virginia Tech majoring in English and Political Science, was an intern at the Water Center in Spring 2006.

Water Central thanks John Bock, Grundy Project Manager for the Corps of Engineers; Chuck Crabtree, Grundy Town Manager; Ken Brittle, Rob Griffith, and Phil East, all of VDOT; and the Natural Hazards Center in Colorado for their assistance with this article.

TEACHING WATER Especially for Virginia's K-12 teachers

This Issue and the Virginia Standards of Learning

Below are suggestions for Virginia Standards of Learning (SOLs) that may be supported by this issue's Feature article, Science articles, and Water Status Report. Abbreviations: BIO = biology; CE = civics and economics; ES=earth science; GOVT = Va. and U.S. government; LS=life science; US.II = U.S. History; WG = world geography.

Newsletter Section	Science SOLs	Social Studies SOLs
Feature (Grundy flood mitigation project)	6.9	WG.2, WG.6, WG.12, GOVT. 8, GOVT. 9
Science (drinking water research)	6.5, 6.9, ES.9	GOVT.16
Water Status (precipitation and two drought items)	4.6, 4.8, 6.5, 6.9, LS.12, ES. 7, ES.9, ES.13	WG.2

SCIENCE BEHIND THE NEWS

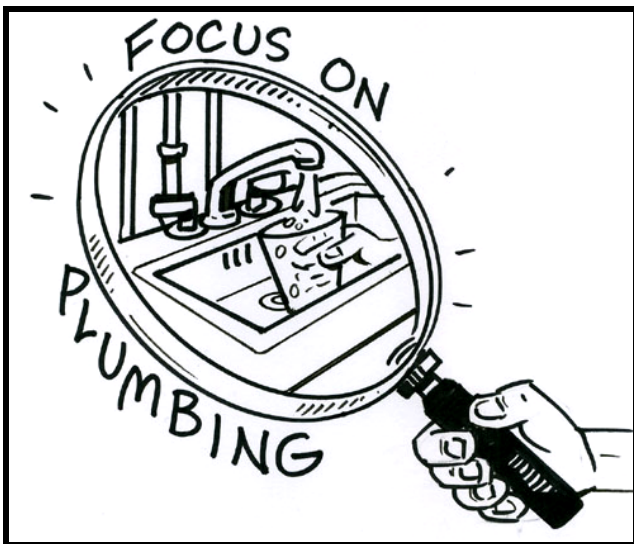
Student Research on Drinking Water Infrastructure

The following five reports are products from “Towards Sustainable Materials Use for Drinking Water Infrastructure,” an interdisciplinary investigation of the materials used in home plumbing. Experts from environmental engineering, food science, economics, hydraulics, chemistry, and microbiology teamed together to evaluate the performance of plumbing materials with respect to costs, health effects, and impacts on water quality, taste, and odors. Our goal has been to understand materials and their chemical and physical interactions with water so that appropriate materials can be matched to different water qualities. This work was funded under the National Science Foundation’s “Materials Use: Science, Engineering, and Society” effort. This innovative research program supports fundamental science that can immediately and directly benefit a consumers’ daily life.

People need water to live, and water is transported in pipes, so understanding how to transport water without degrading its quality is a topic that concerns everyone. Read on!

—Andrea Dietrich

Andrea Dietrich is a professor in the Virginia Tech Civil and Environmental Engineering Department.



Report 1. A Tiny Hole in Drinking Water Pipes Can Mean a Lot of Problems

By Ewa Kleczyk and Darrell Bosch

Have you ever thought what a tiny hole in your drinking water pipes might do to your house? Most likely, you have not spent much time thinking about your plumbing system, but a tiny hole in your pipes might cost you a lot of money and time. This article explains how miniscule holes can create huge problems.

Background

The small holes in copper pipes are called **pinhole leaks**. They commonly are caused by pitting corrosion, a type of corrosion concentrated on a very small area of an inner pipe. In most cases, pinhole leaks are hard to detect; if they are visible, they appear as a green, wet area on pipe and porcelain fixtures. Damage from the pinhole leaks can include collapse of walls and ceilings as well as development of mold on the surface of walls, floors, and ceilings (mold exposure can cause allergic reactions, such as irritation of eyes, skin, and throat).

Pinhole leaks occur nationwide, but they appear to be more common in the following states: California, Florida, Maine, Maryland, Massachusetts, Ohio, Tennessee, Virginia, and South Carolina. Some areas (for example, parts of Florida) have actually banned the use of copper piping in order to control the rising number of incidents.

Maryland Drinking Water Survey Survey Development

In July 2004, the Maryland Home Drinking Water Assessment Survey was conducted to learn more about the extent of pinhole leaks problem in household drinking water plumbing systems. The survey was part of a larger research effort funded by the National Science Foundation.

Mail surveys were sent to Maryland residents in the suburbs of Washington, D.C., to investigate their experiences with pinhole leaks in copper pipes. This area was selected because utility customers reported a large number of pinhole leaks to the Washington Suburban Sanitary

Commission.¹ The sample was divided by zip code and some zip codes with high reported incidence of pinhole leaks were sampled more heavily. A total of 5,015 Maryland residents received the survey, 1,128 responses were received, and 1,022 surveys responses were used in the analysis (106 responses were dropped from the study because they were incomplete). The survey analysis focused on the incidence of pinhole leaks; associated financial, time, and emotional costs; and organizations contacted by respondents when the problem arose.

Pinhole Leak Occurrences

Survey results indicate that pinhole leaks in copper home plumbing systems are a frequently reported problem in the Maryland suburbs of Washington, D.C. Three-hundred sixty-six respondents (36 percent) reported incidents of pinhole leaks in copper pipes, occurring mostly in the mid-1990's and the 2000's. Most respondents had one to four leaks; however, 17 percent reported seven or more leaks, with a higher frequency of leaks reported in houses built prior to 1960. Most leaks occurred in cold-water, horizontal pipes located either in the basement or on the first floor.

Costs Associated with Pinhole Leaks

Over half of respondents with leaks reported expenditures of at least \$500 for repairing leaks and associated damage (please see the following table). Seven respondents cited \$12,000 in repair expenses and one person reported more than \$25,000 in damage. Many of the surveyed households pointed out that, in addition to repairing or replacing pipes, they also had to repair damage to ceilings, walls, and floors. In addition, a few respondents moved out of their homes during the renovation periods, which added to their repair expenses. Others mentioned the priceless worth of personal belongings such as family photos, clothes, and furniture damaged by pipe leaks.

Almost a third of those reporting leaks spent at least 20 hours dealing with pinhole leaks and related damage, and almost 75 percent found the experience somewhat or very stressful. Survey respondents felt "aggravated," "helpless," and "worried about future leaks," and they stated that lack of knowledge about the possible causes of

Table 1. Costs of Repairing Pinhole Leaks and Associated Damage in the Maryland Household Survey, July 2004.

Cost	Number of respondents (percent of respondents)
Less than \$100	49 (14)
\$100 to \$500	94 (26)
\$501 to \$1,000	64 (17)
\$1,001 to \$3,000	55 (15)
\$3,001 to \$5,000	41 (11)
More than \$5,000	42 (11)
Do not know	19 (5)
Missing observations	2 (1)
Total	366 (100)

pinhole leaks added to their anxiety. Some respondents cited lack of third party (insurance and utility companies) involvement and responsibility for pinhole leak occurrences and related damage as additional stress.

Organizations Contacted for Help

Respondents dealing with pinhole leaks contacted various organizations and individuals for help. One hundred ninety nine respondents (54 percent of respondents with leaks) reported leaks to plumbers or home supply stores, 81 respondents contacted the water utility, and 68 contacted insurance companies.

Some respondents felt that involvement of the water utility or insurance companies was not adequate in solving this problem. For example, some respondents were concerned about lack of compensation by insurance companies for property damage or increased rates for their insurance premium following claims of property damage from leaks. Others claimed that water utility companies did not educate residents early enough about the corrosion or help adequately with pinhole leaks repairs and damage.

Next Steps

Due to the increasing frequency of pinhole leak occurrences across the nation, the Virginia Tech researchers working on this project will extend the investigation of pinhole leaks nationwide. Research is being done on factors associated with pinhole leak occurrences in home plumbing and costs of pinhole leak damage. Additionally, households' preferences for plumbing materials and their willingness to pay for improved plumbing infrastructure are also being examined. The research findings will inform policymakers, program managers, and

¹ Washington Suburban Sanitary Commission (WSSC), "Pinhole Leaks in Copper Pipes," online at www.wsscwater.com/copperpipe/pinhole_charts.cfm (as of 6/7/06).

water utilities on the importance of reducing corrosion in home drinking water infrastructure.

For Further Reading

E. J. Kleczyk, *et al.* "Maryland Home Drinking Water Assessment." *Proceedings of the 2005 Virginia Water Research Symposium-Balancing Law and Water Science*. Virginia Water Resources Research Center, Blacksburg, Virginia, 2005, pp. 104-113. Online at www.vwrrc.vt.edu/Proceedings.htm (as of 6/7/06).

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Report 2: Consumer Preferences Towards Plumbing Attributes

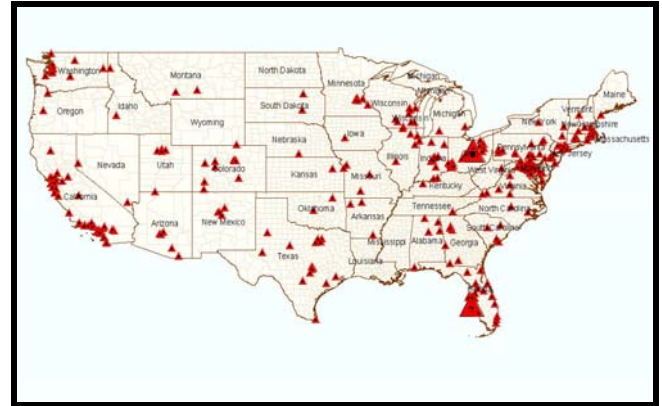
By Juneseok Lee and G. V. Loganathan

Drinking-water distribution involves major and minor systems. The major system is the utility water mains that bring drinking water to houses, and the minor system is the plumbing that carries water within a house. Although the major system is readily recognized as a vast infrastructure system—nearly 1,409,800 km of piping within the United States,² the minor system is at least 5–10 times larger.

In the major water distribution system managed by municipalities and water utilities, costs are distributed among all subscribers. But home plumbing repair and replacement costs are borne by the homeowner. When a pipe has a leak, the homeowner is typically faced with the following issues: water damage cost, repair cost, service disruption, possible lowering of home value, home insurance premium increase or non-renewal, and possible health consequences.

About 90 percent of the domestic drinking water plumbing systems in the United States use copper pipes.³ Recently, there has been a noticeable increase in **pinhole corrosion** in copper plumbing pipes; the following map shows the number of reported leaks by state between 2000 and 2004. As noted in the previous article

by Ewa Kleczyk, **pinhole leaks** are small holes in copper pipes, caused by pitting corrosion, a type of corrosion concentrated on a very small area of an inner pipe. Because a household plumbing system is mostly hidden, damages may not be revealed for some time after a pinhole leak occurrence. When faced with this occurrence, homeowners often need advice on whether to repair pipes or replace them, and on what pipe material to use.



Nationwide distribution of locations reporting pinhole leaks between 2000 and 2004.

From 2003 to 2005, our research in the Virginia Tech Civil and Environmental Engineering Department sought to develop a **decision framework** for affected homeowners. The available data were sparse and did not permit a rigorous analysis. Using simplifying assumptions, we developed an expression for the optimal replacement time by minimizing the total discounted cost. The initial results suggest that when the time between successive breaks is less than two years (the typical age of the plumbing system at this stage is around 22 years), the homeowner should consider replacement.

Another aspect of our research was to assess consumer preferences towards different characteristics of plumbing pipes. All plumbing materials have relative advantages and disadvantages; for example, one type may be easy to install but may not be reliable, while another may be corrosion-resistant but may have health or taste/odor problems.

The alternatives considered in our research included PEX (Cross-linked polyethylene), cPVC (chlorinated Polyvinyl Chloride), and copper with increased wall thickness. We used a tool called "Analytical Hierarchical Process"⁴ to assess

² G. H. Koch, *et al.*, "Corrosion Costs and Preventative Strategies in the United States," *Materials Performance (Supplement)*, July 2002, p. 6, online at www.nace.org/nace/content/publicaffairs/images_cocorr/ccsupp.pdf (as of 6/7/06).

³ S. Marshutz, "Hooked on Copper," *Reeves Journal*, March 2001, online at www.reevesjournal.com (as of 6/7/06).

⁴ T. L. Saaty, "How to Make a Decision: The Analytic Hierarchy Process," *European Journal of Operational Research*, 1990 (48), pp. 9-26.

preferences. The following seven attributes were considered: *price*, including the cost of materials and labor for installation and repair; *corrosion resistance*, the ability of the material to remain free of corrosion; *fire retardance*, the ability of material to remain functional at high temperatures and not to cause additional dangers such as toxic fumes; *health effects*, the ability of material to remain inert in delivering water without threatening human health; *longevity*, the length of time material remains functional; impact on the *resale value* of the home, according to people's preference for a particular material; and *taste/odor*, the ability of material to deliver water without imparting odor or taste. From the attribute ranking, health and taste/odor emerged as the clearly dominant factors in determining the preference for a plumbing material.

For more information on this Virginia Tech research project, please contact Dr. G.V. Loganathan at (540) 231-6211 or gvlogan@vt.edu.

For Further Reading

Loganathan, G.V. and J. Lee (2005). "Decision Tool for Optimal Replacement of Home Plumbing System." *Journal of Civil Engineering and Environmental Systems*, 22(4), pp. 189-204.

Juneseok Lee is a Ph.D. student in the Virginia Tech Department of Civil and Environmental Engineering. G. V. Loganathan is a professor in that department.

Report 3: Plastic Pipes and Water Flavors

By Timothy Heim and Andrea Dietrich

The use of synthetic plumbing materials to convey drinking water has increased significantly in recent decades. Plastics, such as High-Density Polyethylene (HDPE), Cross-Linked Polyethylene (PEX), and chlorinated Polyvinyl Chloride (cPVC) make durable, cost-effective replacements to traditional materials like copper and iron.

Synthetic pipes are easier to install due to their lighter weight and increased flexibility and are cheaper to manufacture. Synthetic materials also are performing other roles in home plumbing; epoxy liners, for example, have now become a popular alternative to re-piping in the event of corrosion and pinhole leaks in copper pipes.

Taste and odor play a critical role in consumers' perception of the quality and purity of their drinking water. Water utilities want to produce a high-quality product that consumers will use with confidence, while consumer

expectations continue to rise due to increased use of bottled water. If new materials cause water to be less palatable to consumers, their benefits as substitute materials are reduced. While all the materials mentioned above meet current National Sanitation Foundation safety standards,⁵ the materials' potential to affect water flavors and consumer preference has not been examined closely.

Researchers in the Virginia Tech Civil and Environmental Engineering Department have been studying the impact that synthetic materials may have on the aesthetic quality of drinking water. The goal of this research is twofold: first, to generate information that will help homeowners and plumbing professionals decide which types of pipe material are appropriate for the water in their area; and second, to develop a standard testing protocol for evaluating the aesthetic influence of new plumbing products. Testing for aesthetic impacts is required in Europe and Australia but has yet to be standardized in the United States.



Plumbing rig used for testing polymer pipe materials. (Photo courtesy of the Virginia Tech Civil and Environmental Engineering Department.)

In 2004-2006 in a Virginia Tech lab facility, different plumbing materials were evaluated by exposing sections of pipe to water for 72-hour periods and then having the water evaluated by trained members of an odor-assessment panel. The panelists compared the water stored in pipes to water stored under the same conditions in laboratory-grade glass flasks (which don't affect the water). Results showed that under these test conditions HDPE, PEX, and epoxy consistently and repeatedly generated detectable odors described by panelists as "waxy/plastic/citrus,"

⁵ More information on standards for plumbing materials can be found at www.nsf.org/consumer/plumbing/ (as of 6/7/06).

“plastic/adhesive/putty,” and “plastic-chemical” respectively, while cPVC did not generate any detectable odors.

Further research in this area is likely to involve studying how the ability of pipes to generate odors changes over longer periods of time, with the goal of developing practical and useable information for those deciding what type of plumbing materials to use.

For more information on this research project, contact Timothy Heim at heimt@vt.edu or Andrea Dietrich at andread@vt.edu.

For Further Reading

Dietrich, A. M., *et al.* “Plumbing Materials: Costs, Impacts on Drinking Water Quality, and Consumer Willingness to Pay.” Proceedings of the 2006 National Science Foundation DMII Research Conference, St. Louis, Mo., July 24-26, 2006.

Timothy Heim graduated in May 2006 with a master’s degree from the Virginia Tech Department of Civil and Environmental Engineering.

Report 4: Copper in Drinking Water—How Does it Taste?

By Jae Hee Hong and Susan Duncan

You have a cup of cold water from your tap in hot summer day—cool, crisp, clean, and refreshing. You gulp it, but the anticipated cool refreshment is altered by a lingering taste. You might notice a dry mouth sensation, and you may say, “This tastes metallic!” That taste perception is possibly related to your plumbing.

A metallic taste may indicate a corroded copper plumbing system. When water travels through such a system, corroded copper is dissolved in the drinking water, causing metallic taste, bitterness, sourness, saltiness, tingling, or astringency.

It’s a good thing that people don’t like the taste of copper in drinking water! If the corroded copper did not have an unpleasant taste, one might keep drinking it and eventually end up with illness. For example, researchers in Chile reported that one spoon-tip amount of copper in a gallon of water—about 4 parts per million (ppm)—can lead to diarrhea, nausea, or abdominal pain. The U.S. Environmental Protection Agency (EPA) has set 1.3 ppm as the limit of copper concentration in drinking water to prevent adverse effects on health that may be caused by long-term intake of copper. The EPA also has established an *aesthetic* standard of 1 ppm copper,

because copper above this level can stain plumbing fixtures and laundry as well as cause metallic- or bitter-tasting water.

In 2004, the Virginia Tech Civil and Environmental Engineering (CEE) Department did experiments to find out how small an amount of copper in drinking water humans can detect. The researchers gave five cups of water to healthy people: one cup had a very small amount of copper and other four cups had no copper at all. The researchers asked people to drink the water and try to pick out the cup that had water with a different taste. They repeated the experiment with continuously decreasing amounts of copper in an odd cup until people could no longer select the odd cup. Surprisingly, many study participants could detect as low as 0.5 ppm of copper, only about 1/3 level of the EPA’s health-based copper limit in drinking water (1.3 ppm). This means that, given our current copper health standards, humans can detect copper in water well before it reaches unsafe levels.



Participants in a water taste test. (Photo courtesy of Andrea Dietrich.)

The CEE research group is now investigating the mechanisms of *how* people taste copper. Sensation of copper, like sensation of foods, depends both on smell and taste. When you chew a food, it releases the molecules that cause aroma and taste. Aromatic molecules move upward to your nose through the tunnel in the back of your mouth, and cells inside your nose detect cues that allow you to distinguish different foods. On the other hand, taste specifically is the sensation you can feel only on the tongue: bitterness, sweetness, sourness, and saltiness. When you detect a flavor, you are both smelling and tasting.

The CEE research group is applying these principles to our perception of copper. One focus is on the breakdown of lipids (fats) in cells of the mouth and nose by copper, on the assumption that

molecules formed during this breakdown are responsible for metallic smell of copper-containing water. Another focus has been astringency, one of the taste sensations caused by copper. The researchers believe copper causes astringency when the metal binds proteins in saliva and makes them precipitate (come out of solution); the proteins are then not as slippery and give the puckering sensation. Further work will investigate how the conditions of drinking water (such as acidity, hardness, or the presence of other minerals) change the amount of *soluble* copper and how that affects the lipid breakdown or precipitation of salivary proteins. We hope that such details of how people perceive copper and how conditions of water influence the perception will help the drinking water industry provide high-quality water to the public.

For more information on this research project, contact Jae Hee Hong at jhhong@vt.edu.

For Further Reading

Dietrich, A. M., *et al.* "Health and Aesthetic Impacts of Copper Corrosion on Drinking Water." *Water Science and Technology* (2004), Vol. 49, pp. 55-62.

Jae Hee Hong is a Ph.D. student in the Virginia Tech Department of Food Science and Technology. Susan Duncan is a professor in that department.

Report 5. Recent Lead Research Prompted by Problems In Washington, D.C.

By Abhijeet Dudi and Marc Edwards

Potable water should have low levels of harmful chemicals and bacteria when collected. Some of the greatest dangers to safe drinking water arise from plumbing systems in buildings. Lead is of particular concern because exposure to lead can result in reduced intelligence, anti-social behavior, and many other ailments. Lead is a challenge because it usually comes from the pipes and plumbing inside and in front of your house. In addition, treatment practices at the water utility supplying your water can affect the potential for lead dissolution from the plumbing.

In 2001, drinking water samples from homes in Washington, D.C., started to show very high lead levels. Hundreds of samples were collected with more than 300 ppb lead, which is more than 20 times the EPA "action limit" of 15 parts per billion (ppb). The unfortunate experience in

Washington renewed research into how lead gets into household drinking water.

Virginia Tech Civil and Environmental Engineering Department (CEE) research into the cause for the sudden increase in lead in Washington drinking water focused on the water's **corrosivity** (the ability of water to corrode plumbing materials and leach metals into the water; it can vary dramatically among waters). In November 2000, to meet other drinking water regulations, the DC Water and Sewer Authority (WASA) had switched its disinfectant from chlorine to chloramine. CEE experiments demonstrated that water containing chloramine is often more corrosive to lead-bearing plumbing than water with chlorine. (Utilities often use corrosion inhibitors to correct for the leaching impact of chloramine.)

In most cases in Washington, the highest lead levels were found at homes with a pure lead distribution pipe supplying the home (lead pipes were legally required for bringing water into homes built before about 1950). In some instances, however, high levels of lead were found in homes *not* supplied by a lead pipe. In these cases, lead solder and new brass plumbing devices inside homes were considered the likely sources. Although the 1986 Safe Drinking Water Act banned the use of *pure lead* devices, lead is still allowed at levels of up to eight percent in brass used to make plumbing devices such as flow meters, faucets, and certain valves. When these devices are used, the brass can be corroded by a reaction with drinking water. It has been difficult to find replacements for these common devices, so they continue to be installed in households and can be a source of lead contamination.



Brass faucet obtained from a hardware store. (Photo courtesy of Abhijeet Dudi.)

Before the outbreak of excessive lead in potable water at Washington, it was widely believed that brass plumbing devices were tested

in a highly corrosive solution and that devices which could leach excessive amounts of lead would not be labeled as “safe” in the marketplace. Between 2002 and 2005, CEE researchers repeated the test used by the National Sanitation Foundation to certify brass devices as meeting safety standards. This research found that the test water was not really very corrosive to lead, leading to labeling of products as safe that might actually pose a danger to the public. It was even demonstrated that a small device made of pure lead could pass the National Sanitation Foundation standard. The Foundation has recently taken steps to ensure that its lead-testing water is sufficiently corrosive, but it will take years before brass meeting tougher standards is available and used by plumbing suppliers.

One other discovery of the CEE research into the D.C. problem was that the rate of lead corrosion can be increased when lead-bearing brass devices are directly connected to copper pipe, a fairly common arrangement. Some experiments demonstrated that the connection to copper pipe could increase the rate of lead leaching by up to 10 times. This result highlights the complexity one may confront when elevated lead is found in homes.

Future work will include reviewing the National Sanitation Foundation standard for faucets, examining the relation of lead in drinking water to blood lead levels, reviewing the feasibility of brass with less than 0.2 percent lead, and examining factors that cause excessive leaching from lead solder (commonly used until the late 1980s).

Testing Your Home Water is a Good Idea

Even if you are served by the best run water company and lead is not generally a problem in your city, you ultimately have responsibility for ensuring that lead is not at unsafe levels in your home. It is advisable, therefore, to have your water tested by a reputable laboratory and, if necessary, take precautions to reduce your exposure to water. This is true whether you live in a new or older home.

Proper testing requires that you allow water to sit motionless inside your plumbing, to give lead a chance to build up by leaching from plumbing. Here is a suggestion how to do this.

- 1) Turn off the water supply or otherwise ensure that no water is drawn for at least eight hours but not more than 18 hours, including for purposes such as flushing toilets.

- 2) Thereafter, fully open the tap most commonly used to collect water for drinking or cooking and collect (in the container provided by the laboratory) the first liter for testing. If possible, also testing other faucets used for drinking.
- 3) Also collect one-liter samples after 30 seconds and after two minutes of flushing.

In some cases, household water lead levels drop to very low values after 30 seconds to 2 minutes of flushing. If this is true, running water in this manner before use will ensure that your water has lower lead. But if your test shows that lead levels *increase* with flushing, the source of lead may be the pipes that connect your home to the larger pipes near the street. In such cases you might decide to invest in inexpensive but effective devices to filter the lead, or make the more costly decision to replace lead service lines or plumbing that might be causing the problem. Replacement of lead service lines should be done in consultation with your utility, because some utilities have programs to replace the publicly owned lead pipe at the same time.

Regardless of the lead levels within your house, do not routinely collect drinking water from hose bibs or bathtub faucets, which are not always manufactured to standards sufficient to produce water fit for human consumption.

For more information on this research project, contact Marc Edwards at edwardsm@vt.edu.

For Further Reading

Dudi, A., *et al.* “Lead Leaching from Inline Brass Devices—A Critical Evaluation of the Existing Standard.” *Journal of the American Water Works Association*, Vol. 97, No. 8 (August 2005), pp. 66-78.

Abhijeet Dudi, a design engineer with McCrone, Inc., in Annapolis, Md., graduated in December 2004 with master’s degree from the Virginia Tech Department of Civil and Environmental Engineering. Marc Edwards is a professor in that department.

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VIRGINIA WATER STATUS REPORT

This section of *Water Central* presents recent and historical data on Virginia's precipitation, stream flow, and groundwater levels (one topic per issue, rotating among the three topics).

Precipitation in Virginia, August 2005—May 2006

The chart below shows precipitation (in inches) at seven National Weather Service observation sites in Virginia. The top number is the **total precipitation for the indicated site, month, and year**, including the equivalent amount of water contained in any snowfall or other frozen precipitation. These values were found (on 6/8/06) at the "Climate" sections of National Weather Service Web sites, as follows:

www.weather.gov/climate/index.php?wfo=rnk, for Blacksburg, Lynchburg, and Roanoke;

www.weather.gov/climate/index.php?wfo=lwx, for Charlottesville and Washington-Dulles; and

<http://mi.nws.noaa.gov/climate/index.php?wfo=akq>, for Norfolk and Richmond. The bottom number (in parenthesis) is the **average precipitation for that month** over the period 1971—2000, according to the National Climatic Data Center, *Climatology of the United States No. 81* (accessed at

www5.ncdc.noaa.gov/climate_normals/clim81/VAnorm.pdf on 6/8/06). The recent monthly amounts (but not the long-term averages) are classified by the National Weather Service as *preliminary* data and are subject to revision; the National Climatic Data Center maintains any edited and *certified* data that are available.

Water Central's most recent previous report on Virginia precipitation (for November 2004-July 2005) appeared in the August 2005 issue (issue #35).

More Virginia climate data and the *Virginia Climate Advisory* are available from the Virginia State Climatology Office, online at <http://climate.virginia.edu>. To reach the State Climatologist's office, phone (434) 924-0548 or send e-mail to climate@virginia.edu.

	Blacks- burg (Station #012)	Charlottes- ville (Station #023)	Lynchburg (Municipal Airport)	Norfolk (Internat. Airport)	Richmond (Byrd Intern. Airport)	Roanoke (Woodrum Airport)	Wash.- Dulles Airport
Aug. 2005	3.64 (3.68)	* (4.14)	2.28 (3.41)	7.61 (4.79)	2.56 (4.18)	3.72 (3.74)	2.32 (3.78)
Sep. 2005	0.25 (3.39)	0.76 (4.85)	0.12 (3.88)	2.90 (4.06)	0.08 (3.98)	0.23 (3.85)	0.15 (3.82)
Oct. 2005	3.33 (3.19)	7.42 (4.22)	7.29 (3.39)	5.18 (3.47)	3.74 (3.60)	5.05 (3.15)	9.22 (3.37)
Nov. 2005	3.15 (2.96)	* (3.74)	4.05 (3.18)	3.79 (2.98)	3.81 (3.06)	3.63 (3.21)	2.49 (3.31)
Dec. 2005	2.20 (2.87)	2.74 (3.26)	3.03 (3.23)	4.30 (3.03)	5.81 (3.12)	2.36 (2.86)	2.93 (3.07)
Jan. 2006	2.76 (3.37)	2.60 (3.71)	3.15 (3.54)	2.68 (3.93)	2.89 (3.55)	3.56 (3.23)	2.40 (3.05)
Feb. 2006	1.14 (3.02)	* (3.30)	2.07 (3.10)	0.65 (3.34)	1.47 (2.98)	1.56 (3.08)	2.38 (2.77)
Mar. 2006	0.69 (3.83)	* (4.05)	0.76 (3.83)	0.52 (4.08)	0.20 (4.09)	0.35 (3.84)	0.07 (3.55)
Apr. 2006	3.93 (3.83)	3.04 (3.34)	2.44 (3.46)	3.65 (3.38)	2.18 (3.18)	3.00 (3.61)	4.86 (3.22)
May 2006	3.00 (4.39)	1.67 (4.86)	1.65 (4.11)	2.96 (3.74)	3.24 (3.96)	1.46 (4.24)	1.80 (4.22)
Total for period	21.09 (34.53)	* (39.47)	25.19 (35.13)	31.28 (36.80)	22.74 (35.70)	23.46 (34.81)	26.82 (34.16)

* Indicates monthly value not found at Web site on June 8, 2006.

VIRGINIA WATER STATUS REPORT—Part 2

Views of Virginia's Relatively Dry Spring 2006



Mountain Lake, Va. (Giles County), May 31, 2006, showing the low level of the lake due to low rainfall. The gazebo on the right is typically at or near the water's edge.

Drought Concerns in the Spring Headlines

- “Water Authority Addresses Drought...,”
Charlottesville Daily Progress, 3/28/06
- “The Driest March on Record?” *Winchester Star*,
3/28/06
- “Dry Times Returning?” *Harrisonburg Daily Record*, 3/29/06
- “Virginia Faces Fear of Drought,” *Richmond Times-Dispatch*, 3/29/06
- “Dry Weather in March Sets Records Across State,” *Roanoke Times*, 4/3/06
- “Low Flow Set March Record in Potomac,”
Richmond Times-Dispatch, 4/10/06
- “Dearth of Spring Showers Costly for Farmers—
Last Month was the Driest March on Record
for Hampton Roads,” *Daily Press*, 4/13/06

From the Virginia Drought Monitoring Task Force

Partners on the Virginia Drought Monitoring Task Force include the following state agencies: Climatology Office, Department of Agriculture and Consumer Services, Department of Emergency Management, Department of Environmental Quality, Department of Forestry, Department of Game and Inland Fisheries, and

Virginia Cooperative Extension. Federal partners include the U.S. Department of Agriculture's Farm Service Agency, the National Weather Service, and the U.S. Geological Survey. The Task Force's Drought Status Reports—issued as conditions warrant—are available online at www.deq.virginia.gov/waterresources/drought.html.

The most recent Virginia Drought Status Report was issued on May 22 (as of 6/7/06). Here is an excerpt from that report.

“During the most recent evaluation period, May 1 through May 17, areas...west of the Blue Ridge and the Roanoke River basin experienced lower than normal precipitation while the eastern portion of Virginia experienced normal to above normal precipitation. This pattern, coupled with the relatively wet end of April, has significantly reduced short-term drought impacts in Virginia. While statewide precipitation for the current water year (beginning October 1, 2005) is in the normal range, statewide precipitation since January 1, 2006, is only 66 percent of normal [see the table on the following page].

“Seven-day average streamflows in the central portion of the state and the lower James River basin are below normal.... [S]treamflows have reacted very quickly to precipitation events between April 1 and May 19. Streamflows will likely decline rapidly without periodic precipitation and this decline will be compounded by the onset of evapotranspiration demands of actively growing vegetation.

“Groundwater levels are below normal in 10 of the 19 real-time drought monitoring wells across the Commonwealth and the remaining 9 wells are in the lower portion of the normal range. Groundwater levels are generally below normal levels in the area of the Commonwealth west of Route 95.

“Levels of large reservoirs such as Lake Moomaw, Smith Mountain Lake, Kerr Reservoir, and Philpott Reservoir are near full but inflows are much below normal and reservoir levels are likely to decline very early during the spring-summer season. No reports of impacts to public water supplies have been received at this time.

Table 1. Virginia Precipitation Departures.

Values are from the Virginia Drought Monitoring Task Force's May 22, 2006, Drought Status Report are **observed rainfall as a percentage of average rainfall** (over the period of record) for the indicated regions and time periods; the percentages are based on *preliminary* precipitation data.

Region	5/1/06 to 5/17/06	3/1/06 to 5/17/06	1/1/06 to 5/17/06	10/1/05 to 5/17/06
Big Sandy	54%	94%	84%	85%
New River	59%	65%	67%	84%
Roanoke	55%	46%	53%	83%
Upper James	39%	56%	62%	89%
Middle James	83%	53%	59%	88%
Shenandoah	63%	52%	70%	93%
Northern Virginia	87%	71%	78%	103%
Northern Piedmont	79%	66%	67%	96%
Chowan	115%	70%	61%	90%
No. Coastal Plain	127%	84%	79%	105%
York/James	127%	68%	67%	91%
Southeast Virginia	136%	75%	67%	96%
Eastern Shore	96%	69%	63%	88%
STATEWIDE	75%	64%	66%	89%

"The Department of Game and Inland Fisheries reports that access has not been affected at any of the public boat ramps in the Commonwealth and the stocking from coldwater and warm water hatcheries is near completion and on schedule. Department lakes are currently at full pool.

"The Governor has received one request from Rappahannock County for assistance in obtaining federal disaster designation."

From the U.S. Drought Monitor

The U.S. Drought Monitor, available online at www.drought.unl.edu/dm/monitor.html, is a weekly nationwide drought assessment by federal agencies and state climatological centers. The Drought Monitor's ratings, starting from the driest, are as follows: D4 = exceptional drought; D3 = extreme drought; D2 = severe drought; D1 = moderate drought; and D0 = abnormally dry.

Here are excerpts on from the Drought Monitor's nationwide weekly summaries in mid-

March, mid-April, and mid-May 2006, on significant developments in Virginia and nearby states.

3/14/06: "For the region as a whole, precipitation totals declined from west to east, with 2 to locally 6 inches falling on southern Ohio, 1 to 3 inches falling on much of eastern Kentucky and Tennessee, 0.5 to 2.0 inches dampening the central and southern Appalachians, and little or none observed along the Atlantic coastal plain.... During the last 90 days, precipitation totals were 4 to 8 inches below normal for most areas from the Delmarva Peninsula southwestward into northern Georgia and adjacent sections of Tennessee and Alabama. This, in conjunction with substantial longer-term precipitation deficits, led to daily record low streamflows at numerous sites from north-central South Carolina northward into south-central Virginia."

4/11/06: "Widespread moderate to locally heavy precipitation (1 to locally 3 inches) fell on central and northern New England, parts of the central and southern Appalachians, eastern sections of Tennessee and Kentucky, northern Alabama, portions of southwestern Georgia, and sections of north-central and east-central Florida. [Moderate or light] precipitation...fell on other dry areas along the Eastern Seaboard. This pattern brought a mixed bag of changes to the dryness and drought conditions in the East.... [A]nother drier-than-normal week in south-central Virginia and the interior Carolinas led to D1 [moderate drought] expansion into much of central and northern South Carolina, and some D2 [severe drought] expansion in North Carolina and adjacent Virginia."

5/11/06: "**The East:** In the northeast, year-to-date totals are beginning to lag behind.... This has led to an expansion of abnormally dry (D0) conditions across more of the region. West Virginia, Maryland, Pennsylvania, and southern New York have all been placed under this D0 area. Totals on the year are generally running 50-75 percent of normal. The dryness is quite pronounced over the past 60 days, with 2 to 6 inch deficits having accrued (25-50 percent of normal). Farther south in the Mid-Atlantic region, some decent rains fell across the coastal plains of the Carolinas (2 to 4 inches or more), resulting in a modest retreat of the D0 and D1 on its eastern edge. However, longer-term deficits (25-50 percent of normal since January 1) are common in these same areas; moving inland, streamflows are at, or near, record low levels for this time of year across the Carolinas and Virginia as well."

VIRGINIA WATER STATUS REPORT—Part 3

Drought Management Lessons from 2002

In many parts of the state the 2002 drought was the worst drought on record. Many municipal water suppliers were forced to impose voluntary or mandatory restrictions on outdoor water uses. A few localities raised water prices in the hopes of providing customers with an additional incentive to conserve water. The drought became so severe that then-Governor Mark Warner imposed the first-ever executive order mandating restrictions on many types of water uses.

The drought prompted the state to require all local governments to develop local water supply plans to help the state better assesses and prepare for future growth and drought conditions.

A recent VWRRC report, *The Effectiveness of Drought Management Programs in Reducing Residential Water-Use in Virginia*, by Greg Halich and Kurt Stephenson, helps identify how effective the 2002 drought-management policies were at reducing residential water use. The purpose of the study was to help local water planners identify what water savings might be achieved through the use of water pricing and voluntary and mandatory water-use restriction programs.

The study analyzed residential water use for 21 Virginia local municipal water systems before, during, and after the 2002 drought. Statistical procedures were used to identify total water savings from drought-management programs and to isolate the changes in residential water use from other factors, such as weather and the time of the year.

The study also examined how water-use reductions were influenced by *program implementation*. For this aspect of the study, local water managers provided data on the types of public information, monitoring, and enforcement activities undertaken during the drought.

The results found significant variation in the water reductions achieved across the state. Programs that asked citizens to reduce water use *voluntarily* were able to reduce water use by seven percent. These water savings, however, were only achieved in localities that devoted significant efforts to informing and promoting the program. Without such aggressive promotion, no water savings were achieved.

Unsurprisingly, *mandatory* water use restrictions resulted in greater reductions in

water use. Local municipal suppliers that implemented programs with an active detection and enforcement efforts were able to reduce water use from 15 to 22 percent. In contrast, mandatory programs implemented without active promotional and enforcement efforts achieved negligible water savings.

While increasing water prices was not a widely used strategy in 2002, the study found that price can be an effective drought-management tool. For example, a modest price increase of \$3 per 1000 gallons was estimated to produce a 15-percent (average) reduction in water-use during the summer months and 13-percent reduction during the fall.

—By Kurt Stephenson

Kurt Stephenson is an associate professor in the Virginia Tech Department of Agricultural and Applied Economics. Report lead author Greg Halich, a graduate assistant at Virginia Tech at the time of the research, is now an assistant professor in Department of Agricultural Economics at the University of Kentucky.

The full report is available as Water Center Special Report SR29-2006 at the Water Center's Web site, www.vwrcc.vt.edu/publications/publications.htm (click "Recent Publications"). For more information, or to request a hard copy of the report, contact the Water Center at (540) 231-5624 or water@vt.edu.



IN AND OUT OF THE NEWS

Newsworthy Items You May Have Missed

The following summaries are based on information in the source(s) indicated in parentheses, usually at the end of each item. Selection of this issue's items ended June 13, 2006. Except as otherwise noted, the localities mentioned are in Virginia and the dates are in 2006.

Frequently used abbreviations include the following: DCR = Va. Dept. of Conservation and Recreation; DEQ = Va. Dept. of Environmental Quality; DGIF = Va. Dept. of Game and Inland Fisheries; EPA = U.S. Environmental Protection Agency; SWCB = Va. State Water Control Board; VIMS = Va. Institute of Marine Science; VMRC = Va. Marine Resources Commission.

SPECIAL NEWS ITEM

Early Stages of a Possible Expansion of the Lake Anna Nuclear Facility

By Amanda Mullins and Alan Rafto

As a result of rising oil prices, diminishing reserves of natural resources, air pollution, and the threat of global warming, nuclear power has recently been receiving renewed attention as a potential major energy source. In fact, Dominion Virginia Power (a division of Dominion Resources, a nationwide energy provider headquartered in Richmond) and two other utility-company consortia have submitted **Early Site Permit (ESP)** applications, a relatively new licensing procedure by the Nuclear Regulatory Commission (NRC). If approved, the permits would help prepare the way for the possible building of the first new nuclear reactors in the United States in over 20 years.¹

According to the NRC, "An ESP is a partial construction permit [that is...] good for 10 to 20 years and can be renewed for an additional 10 to 20 years. The NRC review of an early site permit application addresses site safety issues, environmental protection issues, and plans for coping with emergencies, independent of the review of a specific nuclear plant design."²

In 2003, Dominion applied for an ESP at the Lake Anna Power Station in Louisa County. Though Dominion has not announced plans to build any new reactors at the site "because the economics aren't right at this time," the company is seeking the ESP to "keep [its] options open in the future," according to an April 2006 speech by

Dominion Executive Vice-president and CFO Thomas Chewning in Lexington.³ Since Dominion's application, concerned citizens, environmental groups, government agencies, and company representatives of Dominion have been examining and debating the EPS application and the possibility of new nuclear power in Virginia.

Dominion currently manages four nuclear power units in Virginia—two at the North Anna facility and two in Surry County—which generate about 35 percent of the state's electricity. Dominion also manages two nuclear power plants in other states: Kewaunee Power Station in Carlton, Wisconsin, and Millstone Power Station in Waterford, Connecticut. Nationwide, 103 nuclear power units generate roughly 20 percent of the nation's electricity.⁴

Dominion is seeking an ESP for two potential new reactors. In its initial ESP application, Dominion proposed that one reactor would use cooling towers while the other would be cooled in the same way as the facility's existing reactors, that is, using water from Lake Anna.

Lake Anna, an impoundment on the North Anna River (in the York River watershed), consists of a 9,600-acre main reservoir and a 3,400-acre "Waste Heat Treatment Facility" (WHTF). The lake was built in 1972 primarily for the purpose of cooling the nuclear reactor. Waters in the WHTF are separated from the main reservoir by a series of dikes. Generally the WHTF, which is not open to the general public but is accessible to private lakeside owners, is referred to as the "hot side" of the lake; the main reservoir, which is open to the general public, is referred to as the "cold side." In the facility's current cooling operation, water is pumped from the main

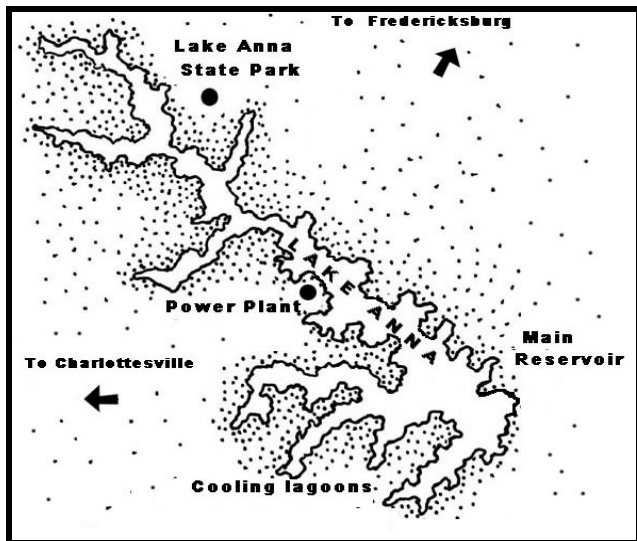
¹ Richard M Roberds, "A Future for Nuclear Power in Virginia," *Virginia Issues and Answers* (Fall 2004), p. 25.

² Nuclear Regulatory Commission, "Early Site Permits—Licensing Reviews," online at www.nrc.gov/reactors/new-licensing/esp.html (as of 5/8/06).

³ Mr. Chewning's remarks are available at www.dom.com/about/speeches/041906_print.jsp (as of 5/8/06).

⁴ Roberds, "A Future for Nuclear Power in Virginia," pp. 25-26.

reservoir and used to cool the two existing reactors. Cooling water exits the station into the WHTF at about 14 degrees F higher than when it was drawn in at the intake structure. This heated water is cooled in the WHTF's three cooling lagoons before finally being released back into the main reservoir of the lake.



A draft Environmental Impact Statement released by the NRC in 2005 indicated that the addition of another cooling system of this type could occasionally raise the temperature in the discharge canal of the WHTF to 108 degrees Fahrenheit. The environmental assessment also indicated that cooling the third reactor with lake water could cause the main reservoir level to fall below the drought threshold of 248 feet above mean sea level (the lake's normal level is about 250 feet) about 12 percent of the time, compared to Dominion's estimate of about five percent of the time under existing operations.

Release of the environmental impact assessment generated about 5,000 comments to the NRC. A February 2005 public hearing in Louisa on the draft statement drew several hundred people, both to voice support of additional nuclear capacity and to voice concerns that the lake's ecosystem and recreational uses might be harmed under the initial proposal.

In response to concerns expressed by regulatory agencies, Friends of Lake Anna (a new community group formed after the environmental impact assessment was released), and other citizens, Dominion in October 2005 announced that it would change its proposal for cooling a proposed third reactor. The modified proposal to the NRC and the Virginia Department of Environmental Quality (DEQ) calls for cooling the third reactor by using a combination of wet and

dry cooling towers, rather than the lake waters alone. Richard Zuercher, spokesperson for Dominion, stated in the *Fredericksburg Free Lance-Star* (10/26/05) that the company believes this approach addresses both the heating and water-consumption concerns of residents and state regulators. Dominion's new plan also calls for a larger reactor with a greater power output, a necessary change according to Zuercher, who stated in the (Louisa) *Central Virginian* (2/23/06) that more electricity is needed to operate the cooling towers. Dominion's plan to cool the fourth unit using dry cooling towers did not change.

As a result of these changes in Dominion's proposal, the NRC announced in January 2006 that it needed more information on Dominion's revised building plans, and the agency pushed back its final decision on Dominion's application for an ESP to Fall 2007.

(Sources for this item, in addition to those cited above, included Wikipedia Encyclopedia, en.wikipedia.org/wiki/lake_Anna, 5/11/06; *Charlottesville Daily Progress*, 9/26/05; and *Fredericksburg Free Lance-Star*, 5/7/05, 8/18/05, and 1/7/06. *Water Central* thanks Judson White and Mike Duffie of Dominion Virginia Power for providing additional information.)

Other News In Virginia...

- The **Virginia Marine Resources Commission** (VMRC) met February 28; March 28; April 25; and May 23. Minutes of these meetings are available at the Virginia Regulatory Town Hall Web site, www.townhall.state.va.us/Meeting/ListMeeting_Past.cfm. Some of the news-making actions at these meetings were the following:

- (Feb. 28) Voted to lift its 12-year moratorium on **American Shad fishing**, allowing a small number of commercial fishers to keep a limited "by-catch" of shad (five per day) from the York, Rappahannock, and James rivers. (*Virginian-Pilot*, 3/6/06)

- (March 28) Considered a request from the Virginia Seafood Council to increase the number of **non-native Asian oysters** (*Crassostrea ariakensis*) in aquaculture experiments to 2.5 million (from 1 million in 2005). The VMRC commissioner was expected to approve the proposal in April. (*Daily Press*, 3/1/06)

- (April 25) Agreed to issue state permits to seafood companies who wish to develop **new native oyster** (*Crassostrea virginica*) **aquaculture farms** in the Coan and Yeocomico rivers on the Northern Neck peninsula and in the Ware River in Gloucester County. The largest

project, by Cowart Seafood Corporation, would place hundreds of steel cages on about 24 acres of the Coan River, a previously undisturbed Potomac River tributary. A number of Ware River residents protested plans by Ward Oyster Company to set over 2,000 cages in the shallow water near their waterfront properties; the residents asserted that the two-foot, 100-pound cages would pose boating hazards, impair scenery, and lower property values. (*Virginian-Pilot*, 4/26/06)

- (May 23) Levied fines of \$14,621 and \$15,000 on a development company and a contractor, respectively, for **dredging violations** during work to deepen part of the Lafayette River to allow for a boat basin and community pier in Tanner's Landings, a Virginia Beach condominium development under construction. The violations included working without a permit, cutting an illegal channel through wetlands, and dumping river-bottom materials at the wrong disposal site. (*Virginian-Pilot*, 5/24/06)

- The **State Water Control Board** (SWCB) met March 15 and June 1. Minutes of these meetings are available at the Virginia Regulatory Town Hall Web site, at www.townhall.state.va.us/Meeting/ListMeeting_Past.cfm. Some of the news-making actions at these meetings included the following:

- (March 15) Approved a settlement calling for Carroll's Foods to pay a \$39,000 penalty for **water-pollution violations** in 2005 at four of its farms in Isle of Wight County and Sussex County. The Board also Fined Perdue Farms, Inc., \$18,300 for pollution violations in 2005 at the company's poultry-processing plant in Accomack County, and fined Tyson Foods, Inc., \$25,700 for unpermitted pollutant releases (ammonia and other pollutants) from its poultry-processing plant in Hanover County in summer 2005. (*Richmond Times-Dispatch*, 3/16/06, and SWCB meeting minutes)

- (March 15) Proposed regulations to create a **nutrient-credit trading market** for sewage-treatment plants and factories. The 2005 General Assembly passed legislation (HB 2862/SB 1275) calling for establishment of nutrient exchange or trading program for point-source dischargers of nitrogen and phosphorus, in order to reach nutrient-cap goals in the Chesapeake Bay. The SWCB took public comment in April and May and is expected to adopt regulations in summer 2006. (*Richmond Times-Dispatch*, 3/16/06)

- (June 1) Adopted amendments to the Water Quality Standards (9 VAC 25-260) to set **nutrient criteria for lakes and reservoirs**. The adopted amendments were to be published in the *Virginia Register* for 30 days, submitted to the Governor

for final approval, and then submitted to the U.S. EPA-Region 3 for review and approval. After EPA approval, the effective date of the regulations will be published in the *Virginia Register*. (Jean Gregory, Va. DEQ, 6/2/06 e-mail)

- (June 1) Approved an agreement with Riverton Associates, a developer based in Midlothian (Chesterfield County), for the latter to pay a \$25,195 fine for **wetland and stream damages** that occurred during construction of a 120-home development in Powhatan (Powhatan County). The company also agreed to spend about \$110,000 for wetland and stream restoration. (*Richmond Times-Dispatch*, 6/2/06)

- The **Bedford City** Council voted February 28 to pay \$250,000 for an engineering plan to address **groundwater contamination from a closed city landfill**. The City still faces a \$2.4 million lawsuit from a Bedford County resident whose property was affected by the contamination. (*Roanoke Times*, 3/1/06. For a previous *Water Central* item: Apr. 2004, p. 16.)

Landfills and groundwater were recently in the **Albemarle County** news, as well. In March the Rivanna Solid Waste Authority met with county residents to discuss options for removing and treating millions of gallons of leachate trapped in a cell of a closed landfill in Ivy. In the 1990s, the Authority and local residents reached a lawsuit settlement over contamination from the landfill. (*Charlottesville Daily Progress*, 3/24/06)

- In March, the Virginia chapter of the Sierra Club, the Amphill Rayon Workers Union, and the United Steelworkers International Union requested the U.S. EPA and the Virginia Department of Environmental Quality (DEQ) to investigate whether the **chemical PFOA** (perfluorooctanoic acid), used in making Teflon, was discharged into groundwater or the James River near at the **DuPont Co.'s Spruance plant in Chesterfield County**. The EPA's Science Advisory Board has labeled PFOA as a likely carcinogen. Discovery of the chemical in blood of some workers and in groundwater near a West Virginia plant led to a \$16.5-million EPA penalty against DuPont (for withholding information) and a \$107-million settlement of a lawsuit by residents near the West Virginia plant. DuPont has stated that it stopped using PFOA at the Spruance plant in 2004. DuPont and seven other companies have agreed to an EPA request to eliminate use of PFOA by 2015. (*Richmond Times-Dispatch*, 3/3 and 3/21/06.)

- About 150 people gathered on March 16 in **Virginia Beach** to discuss the **status of the**

Back Bay watershed and how development in Hampton Roads might affect the area's high level of wildlife diversity. The 66,700-acre area between Dismal Swamp and Back Bay supports over 900 species of animals. (*Virginian-Pilot*, 3/17/06)

•On March 21, the **Stafford County** Board of Supervisors directed the county attorney to make an offer to buy 3,200 acres on the **Crow's Nest peninsula**, the focal point of a current proposal for a 688-home development and of long-time efforts to preserve the area from development. (*Fredericksburg Free Lance-Star*, 3/22/06. For a previous *Water Central* item: Feb. 2006, p. 19.)

Also in Stafford County, work may begin by the end of 2006 on a **new reservoir** on Rocky Pen Run (Rappahannock River basin) in southern Stafford. Intended to meet projected water demand for 50 years, the reservoir is estimated to cost \$77 million, cover 585 acres, affect 106 properties, and displace 25 to 30 households. (*Fredericksburg Free Lance-Star*, 4/3/06)

•In March and April, **International Paper Co. announced plans to sell large forest tracts** in Virginia and other southeastern states. In Virginia, the intended sales include 130,000 acres in western Tidewater and Southside to private investors and 20,000 acres in southeastern Virginia to the Nature Conservancy. Overall, the company intends to sell about seven million acres. (*Virginian-Pilot*, 3/29 and 4/5/06; *Daily Press*, 3/29/06).

•Here are three recent **offshore oil/gas exploration developments**. 1) The U.S. Minerals Management Service is expected by August to publish an environmental study of a federal plan to allow oil and gas exploration between 3 and 200 miles off Virginia's coast. This would be the first Atlantic Coast exploration since a moratorium was imposed over 20 years ago. A final decision is expected by May 2007. 2) In April, Gov. Tim Kaine proposed, and the General Assembly passed, a substitute provision to the state energy plan bill (SB 262) that called for the federal government to allow *exploration* of natural gas at least 50 miles offshore (previously, SB 262 had called for lifting of the federal moratorium on exploration *and* development of offshore reserves). 3) On May 18, the U.S. House of Representatives defeated a proposal to remove a Congressionally-imposed moratorium on offshore oil and gas drilling. (*Virginian-Pilot*, 4/5, 4/8, and 5/19/06. For a previous *Water Central* item: Feb. 2006, pp. 6 and 14.)

•In April, the **Fredericksburg** City Council approved a permanent **conservation easement** on over 4,200 acres that the city owns along the **Rappahannock and Rapidan rivers**. (*Fredericksburg Free Lance-Star*, 4/12/06. For a previous *Water Central* item: Feb. 2006, p. 20.)

•Department of Game and Inland Fisheries (DGIF) officials believe a private contractor has successfully eradicated **Zebra Mussels from an abandoned quarry in Prince William County**. The contractor used potassium chloride in January and February to kill the non-native, invasive mussels. Federal grants paid for most of the \$365,00 eradication contract. (*Richmond Times-Dispatch*, 5/11/06. For a previous *Water Central* item: Oct. 2002, p. 19.)

•In May, Dominion Virginia Power announced plans to build a new **coal-burning power plant near St. Paul (Wise County)**. The \$1-billion plant is to include technology to reduce water used for cooling and steam from a typical 10 million gallons per day (MGD) to 1 MGD. The plant's water supply is to be the **Clinch River**. Dominion expects to file for DEQ permits in summer 2006 and hopes to begin construction in 2008. (*Richmond Times-Dispatch*, 5/12/06)

•In May, **Kentucky threatened to sue** Virginia if the Va. Department of Mines, Minerals and Energy (DMME) approves a **permit for Consol Energy to discharge salty mine water** into the Levisa Fork of the Big Sandy River in Buchanan County. Up to now, the water—which seeps into a Buchanan County mine—has been pumped into abandoned mine shafts for storage, but the company wants to start removing the water. The permit being considered would allow discharge of 384 to 10,000 gallons per minute of mine water for 17 years. Kentucky is urging Virginia to modify the permit to require Consol to treat the water before discharge and to do more testing. (*Richmond Times Dispatch*, 5/24/06)

•A **\$276,000 federal grant** will help Virginia continue **weekly monitoring at 50 beach sites** for bacteria and other water-quality indicators. U.S. EPA grants since 2001 have helped Virginia increase beach-monitoring frequency and improve monitoring equipment. The Virginia grant is part of \$9.8 million in beach-monitoring funds that EPA expects to award nationwide this year. (*Richmond Times-Dispatch*, 5/29/06)

•On June 7, the **Albemarle County** Board of Supervisors endorsed a **water-supply project** intended to meet demand in the Charlottesville

area through 2055. The project, recommended by the Rivanna Water and Sewer Authority after years of study and public debate, will expand the Ragged Mountain Reservoir by 45 feet and connect it via a 9.5-mile pipeline to the South Fork Rivanna Reservoir. In April, the Authority chose this plan over the chief competing option, a 24-mile pipeline to the James River.

(*Charlottesville Daily Progress*, 4/19 and 6/8/06)

In another water-supply development concerning the James River, the Va. DEQ in June approved a permit for **Fluvanna and Louisa counties** to withdraw 3.1 million gallons per day from the James. The counties will split the estimated \$19-million cost of building a pipeline, treatment plant, and other structures. The pipeline will serve several developing areas in the fast-growing counties. (*Charlottesville Daily Progress*, 3/18 and 6/13/06)

•The **Shenandoah River Fish Kill Task Force** is continuing to investigate fish health and water-quality conditions in North Fork, South Fork, and main stem of that river, including discoveries this year of Northern Hogsucker deaths in the main stem Shenandoah. Kills in 2004 and 2005 affected Smallmouth Bass and Redbreast Sunfish, which species have also been found in kills this year. The Task Force is preparing plans and a budget for work expected to continue through 2007. The Task Force encourages anyone seeing unusual conditions or problems with fish to contact the DEQ Valley Regional Office at (540) 574-7800. (DEQ Press Release, 6/6/06. For a previous *Water Central* item: Feb. 2006, p. 21.)

•Here are some **Chesapeake Bay items**:

••On April 4, the Virginia Court of Appeals reinstated the **Chesapeake Bay Foundation's lawsuit** over the wastewater discharge permit granted by the Va. DEQ in June 2004 to the Phillip Morris tobacco plant in Chesterfield County. The Appeals Court reversed the Chesterfield County Circuit Court ruling that the Bay Foundation lacked standing to sue. The Bay Foundation lawsuit seeks stricter nitrogen limits in the permit. (Associated Press, 4/5/06. For a previous *Water Central* item: Nov. 2004, p. 21.)

In another Bay-related court case, the **Virginia Supreme Court** on April 21 upheld the **Northampton County** Board of Zoning Appeals' refusal to grant to the BECO Construction company a variance on 100-foot waterfront buffers called for in the 1988 Virginia Chesapeake Bay Preservation Act. (*Virginian-Pilot*, 5/6/06)

••In February, researchers at the Virginia Institute of Marine Science (VIMS) applied for a

federal grant to do a **comprehensive study of mycobacteriosis disease in Striped Bass** in the Bay. The disease is one suspected cause of an increase since 2000 in the non-fishing death rate of Striped Bass. (*Daily Press*, 3/1/06)

••“Trash free by 2-0-1-3!” That could be the cheer of the Alice Ferguson Foundation, the World Bank, several other companies, and several Virginia and Maryland localities who have signed the **Trash Free Potomac Watershed Initiative 2006 Action Agreement**. Signers pledge to locate trashy areas and develop strategies to rid the Potomac of litter by 2013. More information is available online at www.potomaccleanup.org (Associated Press, 2/13/06)

••Virginia failed to impose a cap of 105,000 metric tons annually on the **harvest of Menhaden** from the Chesapeake Bay. The Atlantic States Marine Fisheries Commission voted in August 2005 to impose the cap (Virginia and North Carolina voted against it). The 2006 Virginia General Assembly killed bills that would have imposed the cap, and a 2005 state law in effect prevented Gov. Kaine doing so. That law requires the governor to act at least 30 days before Menhaden season on May 1, but it also allows the governor to act *only* if the legislature is not in session. The Assembly's special budget session, beginning March 27, precluded action by the governor. (*Virginian-Pilot*, 4/1/06. For a previous *Water Central* item: Nov. 2005, p. 18)

••A recent report by the Chesapeake Bay Program indicated an increase of over 78,000 acres (seven percent) in **submerged aquatic vegetation** (SAV, or “Bay grasses”) across the entire Bay in 2005. But this report did not include a late-2005 die-off of Eelgrass in Virginia's Bay portion. The report is available online at www.chesapeakebay.net (or phone 800-YOUR-BAY). (*Virginian-Pilot*, 5/26/06)

...and Outside of Virginia

Unfortunately, *Water Central* had no space in this issue for out-of-state news. This section will return next issue.—*Editor*

A Final Word

•“Only about one percent of the population understands that they are part of a watershed.” —Tracy Bowen, executive director of the Alice Ferguson Foundation, on the importance of actions along tributaries to the goal of a trash-free Potomac River. (*Washington Post*, 4/6/06)

N O T I C E S

If you would like to receive a weekly e-mail notification about *upcoming meetings, conferences, and other events related to water quality*, you may do so by joining the Virginia Water Monitoring Council. Contact Jane Walker at (540) 231-4159 or janewalk@vt.edu.

State Meeting Review

This section presents a list of most water-related public meetings and hearings that occurred February 22—May 31, 2006, as listed on the **Virginia Regulatory Town Hall** Web site, at www.townhall.state.va.us/Intro.cfm. The Town Hall site posts minutes of these and all public meetings by Virginia's boards, commissions, and departments. The list below includes the name of a contact person for further information. To find the e-mail address or phone number of the contact people, go to the Regulatory Town Hall Web site, click on Meetings (Future or Past), and then click on the particular event. You can also request

state employee phone numbers by calling (800) 422-2319, and you can find the e-mail address of any state employee online at www.employees.state.va.us/directory-search.cfm.

Total Maximum Daily Load (TMDL) Meetings

TMDL-related meetings were held regarding the following waters and water-quality impairment issues (listed alphabetically by localities). The contact people listed for TMDL meetings are Virginia Department of Environmental Quality staffers, unless otherwise noted. Information on the status of all TMDLs in Virginia is available online at <http://www.deq.state.va.us/tmdl>

Location	Water(s) & Impairment	Larger River Basin	For More Information
Augusta County	Lewis Creek for benthic impairment	Shenandoah	Robert Brent
Bedford County	Beaverdam Creek for bacteria	Roanoke	Mary Dail
Bedford & Campbell counties	Big Otter River & several tributaries for bacteria	Roanoke	Jason Ericson
Fauquier County	Carter, Deep, Great, & Thumb Runs for bacteria	Rappahannock	Charlie Lunsford
Frederick County & Winchester	Abrams & Opequon creeks for bacteria & aquatic life impairment	Potomac	Tara Sieber
Hanover, King William, Louisa, New Kent, Orange, & Spotsylvania counties	Pamunkey River watershed (several streams) for bacteria	York	Chris French
Northumberland County	Shellfish waters for bacteria	Potomac & Chesapeake Bay	Chris French
King George & Westmoreland counties	Mattox Creek for bacteria	Potomac	Chris French
Rockingham & Shenandoah counties	North Fork Shenandoah River & Stony Creek for bacteria	Shenandoah	Robert Brent
Shenandoah County	Mill Creek for bacteria, benthic, & temperature; Stony Creek for bacteria	Shenandoah	Robert Brent
Suffolk	Nansemond River watershed for bacteria	James	Jennifer Howell
Virginia Beach	Broad, Linkhorn, & Lynnhaven bays for bacteria	Chesapeake Bay	Chester Bigelow
York County, Hampton, & Poquoson	Shellfish waters for bacteria	Chesapeake Bay	Chester Bigelow

Other Recent State Meetings and Hearings
(Items are listed alphabetically by agency or group, then by date.)

DCR Outdoors Plan Technical Advisory Committee meeting on **development of 2007 Virginia Outdoors Plan** (May 10). More information: John Davy.

Department of Environmental Quality (DEQ) public hearings on **landfill permit issues regarding groundwater protection** in Accomack County (May 18), Bedford County (Apr. 6), Nelson County (Apr. 18), and Pittsylvania County (Apr. 12). More information: Larry Syverson.

DEQ public meeting on the **evaluation of the Virginia Coastal Zone Management Program** from September 2003 to the present (May 15). More information: Laura McKay.

Department of Mines, Minerals and Energy (DMME)'s **Mined Land Reclamation Advisory Committee** (Feb. 23). More information: Leslie Vincent.

Soil and Water Conservation Board's **advisory committee on dam safety regulations** (May 1). More information: David Dowling.

Soil and Water Conservation Board's **advisory Committee on stormwater-management permit regulations** (May 4 and 18). More information: David Dowling.

State Water Control Board (SWCB) **Advisory Committee on Wastewater Reclamation and Reuse Regulations** (Feb. 27, Mar. 30, and May 31). More information: Valerie Rourke.

SWCB public hearings on proposed **Tier III Exceptional Water designation** for the following: North Fork Buffalo River, Pedlar River, and tributaries in Amherst County (Mar. 21); Simpson Creek tributaries in Alleghany and Botetourt counties (Mar. 27); More information: David Whitehurst.

SWCB public hearing on proposed **nutrient-criteria regulations for certain lakes and reservoirs** (Mar. 23). More information: Jean Gregory.

SWCB public hearing on proposed amendments to the **Virginia Water Protection Permit**, addressing several issues regarding water supply, withdrawals, and minimum instream flow requirements (several Mar. and Apr. dates). More information: Scott Kudlas.

SWCB **annual joint meeting with the Air Pollution Control Board and the Waste Management Board** (Apr. 18). The agenda included a public forum; presentations by environmental, governmental, health, and manufacturing organizations; guidelines for

environmental civil penalties; and the 2006 General Assembly session. More information: Cindy Berndt.

SWCB public hearings on a general VPDES permit regulation for **nitrogen and phosphorus discharges and trading** in the Chesapeake Bay watershed (May 23 and 24). More information: Kyle Winter.

Regular Meetings of Statewide Boards and Commissions
(Web sites listed were functional as of 6/13/06)

Chesapeake Bay Local Assistance Board—meets March, June, September, and December. The Board's Northern and Southern Area Review Committees, which review compliance by local Bay Preservation Area programs, meet in February, May, August, and October. More information: (800) CHESBAY; www.cblad.state.va.us.

Groundwater Protection Steering Committee—meets third Tuesday of odd-numbered months. More information: www.deq.virginia.gov/gwpsc/.

Marine Resources Commission—meets monthly. More information: (757) 247-2200, TDD (757) 247-2292; www.mrc.state.va.us.

Professional Soil Scientists and Wetland Professionals Board—meets quarterly. More information: Dept. of Professional and Occupational Regulation, (804) 367-8500, TDD (804) 367-9753; www.state.va.us/dpor/ssc_main.htm.

Scenic River Advisory Board—For meeting schedule and other information: Dept. of Conservation and Recreation (DCR), (804) 786-1712 (central office number).

Soil and Water Conservation Board—meets bimonthly. More information: DCR, (804) 786-1712; www.dcr.virginia.gov/sw/vs&wcb.htm.

State Water Control Board—meets March, June, September, and December. More information: Dept. of Environmental Quality (DEQ), (800) 592-5482; www.deq.virginia.gov/cboards/homepage.html#water

Waste Management Board—meets about three times per year. More information: DEQ, (800) 592-5482; www.deq.virginia.gov/cboards/homepage.html#waste

Waterworks and Wastewater Works Operators Board—meets March, June, September, and December). More information: Dept. of Professional and Occupational Regulation, (804) 367-8500, TDD (804) 367-9753; www.state.va.us/dpor/www_main.htm.

Other Notices

Invasive Species Management Plan

The Virginia Invasive Species Management Plan, completed in December 2005 by the Virginia Invasive Species Council, describes the problems of invasive species in Virginia, summarizes pertinent laws and regulations, and proposes a number of actions. The plan is available online at www.dcr.virginia.gov/dnh/vaisc/. More information: (804) 786-7951, or infovainvasivespecies@dcr.virginia.org. (Please see the Aug.-Sep. 2001 *Water Central*, p. 7, for an article on aquatic invasive species.)

Rappahannock River Boat and Septic Tank Pumping Initiative

The Friends of the Rappahannock's "Pump for the Rivah" program, launched in April with the logo shown below, encourages boaters to dump vessel waste at approved marina stations and homeowners to have septic tanks inspected and pumped every three years. The program's Web site, riverfriends.org/pump.html, provides information on approved marinas and septic tank maintenance contractors in the lower Rappahannock basin. More information: (804) 436-9809 or pump@riverfriends.org.



(Used with permission of Friends of the Rappahannock.)

2006 Annual Report of the Ground Water Protection Steering Committee

The 2006 annual report, along with previous annual reports going back to 1995, is available online at www.deq.virginia.gov/gwpsc/pubs.html. For a printed copy or more information: Mary Ann Massie at (804) 698-4042 or mamassie@deq.virginia.gov.

For Bacteria Monitors

The Winter 2006 edition of *The Volunteer Monitor* newsletter is an excellent guide to the various products available for monitoring bacteria in waterways. The newsletter and more volunteer monitoring information are available online at

www.epa.gov/owow/monitoring/volunteer/. Most back issues are also available in print for \$2 apiece by contacting the editor at *The Volunteer Monitor*, 50 Benton St., San Francisco, CA 94112, or ellieely@earthlink.net.

Watershed Planning Handbook

In October 2005 the U.S. EPA released a draft version of *Handbook for Developing Watershed Plans to Restore and Protect Our Waters*. The book is intended to help communities, organizations, and government agencies. Available from the Nat. Service Center for Env. Publications, (800) 490-9198, or ncepimal@one.net; request EPA 841-B-05-005.

Upcoming Conferences and Workshops

In Virginia

•**Citizens for Water Quality (CWQ) Annual Summit—10th Anniversary.** July 22, Charlottesville (University of Virginia, Clark Hall). Limited travel stipends are available from an anonymous donor. More information: Stacey Brown, (804) 615-5036 or stacey@vasos.org; Web site: www.virginiacwq.org/calendar.htm.

Elsewhere

•**Environmental Training Institute for Small Communities.** July 25-28, Morgantown, W.Va. Sponsored by the National Environmental Services Center at West Virginia Univ. More information: Craig Mains, (800) 624-8301; Web site: www.nesc.wvu.edu/nesc/institute.htm.

•**"Increasing Freshwater Supplies."** July 19-20, Santa Fe, N.M. Annual conference of the Universities Council on Water Resources and National Institutes for Water Resources. More information: (618) 536-7571; Web site: www.ucowr.siu.edu.

•**Soil and Water Conservation Society International Conference.** July 22-26, Keystone, Colo. More information: SWCS in Ankeny, Iowa, (515) 289-2311 or swcs@swcs.org; Web site: www.swcs.org/en/swcs_international_conferences.

•**Eighth International Conference on Mercury as a Global Pollutant.** August 6-11 in Madison, Wisc. Sponsored by several federal and state agencies and private organizations. More information: James Wiener, 608/785-6454 or wiener.jame@uwlax.edu; Website: www.mercury2006.org.

•**American Water Resources Association's Annual Conference.** November 6-9, Baltimore.

More information: AWRA, (540) 687-8390 or info@awra.org; Web site: www.awra.org.

Also Out There...

From the many water-related publications that arrive in the Water Center's mail or e-mail, here are brief descriptions of some recent, detailed articles

•**“Offshore 101—Exploring for Answers”**—A series of over 20 guest commentaries addressing basic questions about potential offshore drilling for oil and natural gas off the Virginia coast.

Virginian-Pilot, Mar. 19-Apr. 2, 2006; available online at home.hamptonroads.com/stories/story.cfm?story=101327&ran=233652 (as of 6/14/06). To purchase a print version, phone the Customer Service Department at (800) 446-2005.

•**“Building Green—A New Path”**—Several articles describing trends in constructing more resource-efficient buildings. *Coastal Heritage*, Winter 2006-06. South Carolina Sea Grant Consortium, Charleston. Phone (843) 727-2078 or e-mail john.tibbets@seagrant.org; available online at www.scseagrant.org.

AT THE VIRGINIA WATER CENTER

To reach the Virginia Water Resources Research Center: phone (540) 231-5624; FAX (540) 231-6673; e-mail water@vt.edu; Web site: www.vwrrc.vt.edu. Unless otherwise noted, Water Center publications are available at our Web site, with limited print copies available upon request.

In Memory of Tom Johnson

The Water Center sadly notes the passing of Thomas W. Johnson, 77, on June 5, 2006. Tom was a longtime employee of the Water Center, where his work included developing and serving as the first editor of *Water News*, the Center's first newsletter and predecessor of *Virginia Water Central*. The Water Center is grateful to have known and worked with Tom, and we send our sincere condolences to his family.

New Publications

•*The Effectiveness of Drought Management Programs in Reducing Residential Water-Use in Virginia*, by Greg Halich and Kurt Stephenson (VWRRC Special Report SR29-2006). (A summary of this report's findings appears in the Water Status Report section of this issue of *Water Central*.)

•*A Literature Review for Use in Nutrient Criteria Development for Freshwater Streams and Rivers in Virginia*, by Jane Walker et al. (VWRRC Special Report SR28-2006). Available on the Virginia Department of Environmental Quality Web site at www.deq.virginia.gov/wqs/rule.html (click on “Freshwater Nutrient Criteria,” then “AAC Literature Review for Rivers & Streams”).

Water Center's 2006 Symposium

The **Virginia Water Science and Technology Symposium** is scheduled for

November 1-3, 2006. (Please note that the February 2006 issue of *Water Central* listed the dates as October 23-25; the dates have been changed.) The symposium will be held in the Skelton Conference Center on the Virginia Tech campus. A featured topic will be “Pathogens: Pathways and Monitoring in Natural and Engineered Systems” (on Nov. 2). For more information, contact Tamim Younos at (540) 231-8309 or tyounos@vt.edu.

Recent Awards

Congratulations to Water Center Interim Director **Tamim Younos**, who in May received the “Drop of Water” award from the Southeast Rural Community Assistance Project (SERCAP) for his contributions to rural community drinking water initiative and long-term collaboration with SERCAP.

Congratulations also to **Katie Perkins**, a May 2006 Virginia Tech graduate who served four years as a Water Center undergraduate intern, for receiving in April the annual Rachel Parker-Gwin and Louis Gwin Service-Learning Award from the Virginia Tech Service-Learning Center.

Finally, congratulations to **Amanda Mullins**, a rising senior in English at Virginia Tech, who received an Outstanding Service-Learning Award in April for her work as a writing intern at the Water Center in the Spring 2006 semester. Amanda's work is featured in this issue of *Water Central*, and she also contributed to the February 2006 issue.

Virginia Water Central

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You can find *Water Central* on the Internet at www.vwrrc.vt.edu. If you prefer to read the newsletter there, instead of receiving a paper copy, please send an e-mail requesting this to water@vt.edu, and we will notify you whenever a new issue is posted.

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