

# On Tap

## A Brief History of Drinking Water Regulations

by Jamie Knotts  
NDWC Promotions Coordinator

Twenty-five years ago, Congress passed an act that brought sweeping changes for America's drinking water systems. Since the Safe Drinking Water Act (SDWA) of 1974 went into effect, water systems have encountered many new regulations, such as meeting specific water quality standards, monitoring for contaminants, and submitting water quality reports.

The first SDWA was born after four years of sometimes contentious work by Congress to develop a national program that would ensure the quality of America's drinking water. For the first time, the 1974 act authorized the U.S. Environmental Protection Agency (EPA) to set standards for any contaminant in public water systems that adversely affects public health.

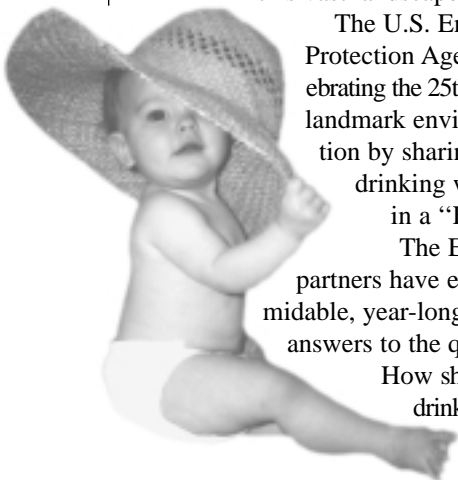
## Safe Drinking Water Protects Our Future

Flying over the country, lakes and ponds sparkle like glass. Rivers thread silvery through the earth tone patchwork. A quarter-century ago, then President Gerald Ford signed the Safe Drinking Water Act (SDWA) into law to protect the public in every tiny community nestled into this vast landscape.

The U.S. Environmental Protection Agency (EPA) is celebrating the 25th anniversary of this landmark environmental legislation by sharing a vision for drinking water in 2025 in a "Futures Forum."

The EPA and a dozen partners have engaged in the formidable, year-long task of gathering answers to the question:

How should we ensure safe drinking water in 25 years?



### How did the SDWA come about?

The U.S. Public Health Service (PHS) set the earliest formal drinking water standards in 1914, says Frederick W. Pontius, P.E., consultant on regulatory affairs and compliance issues in his "History of the Safe Drinking Water" on EPA's Web site (address is located at the end of this article). These standards sought to prevent transmission of communicable diseases in water supplies on interstate carriers, such as buses, trains, and eventually planes.


Community water systems were not forced to comply with the regulations; however, most states and municipalities adopted the PHS standards as guidelines. Under these standards, the PHS set limits for total bacterial plate count, but because they could not agree to specific chemical and physical characteristics, these initial standards were limited to bacteriological water quality issues.

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This Futures Forum was held December 16 at the Hyatt Regency Hotel in Washington, D.C.

The purpose of the Futures Forum was to evaluate challenges facing the nation in ensuring a safe drinking water supply. EPA and its partners have gathered suggestions from individuals all over the country. And EPA has offered online forums for those who wish to contribute at [www.epa.gov/safewater/sdwa25/futures](http://www.epa.gov/safewater/sdwa25/futures).

The all-encompassing question of how to ensure safe drinking water in 2025 is divided into seven subsets of questions: treatment technologies, source water quality, sensitive sub-populations, cost, small systems, unserved population, and research.

For further information about EPA's forum, call Charlene Shaw at (202) 260-2285 or e-mail her at [shaw.charlene@epa.gov](mailto:shaw.charlene@epa.gov). Look for a summary of Futures Forum findings in the Spring 2000 issue of On Tap. 

In This Issue   
**Special  
SDWA  
Anniver-  
sary Issue**

On Tap is a publication of the National Drinking Water Clearinghouse, sponsored by the Rural Utilities Service.



# On Tap

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## On Tap *Toasts SDWA's 25th Anniversary*

We dedicate this issue of *On Tap* to the Safe Drinking Water Act (SDWA)—the major national legislation that has ensured safe drinking water across the country for the last quarter century. We begin with a brief history of SDWA regulations by Jamie Knotts, National Drinking Water Clearinghouse (NDWC) promotions coordinator, and a quick look at the future of water. (See page 1.)

Giraldo has a background in civil engineering, development projects, and business management. He has held several administrative positions in public works and public services, and most recently served as general manager of the Pereira Aqueduct and Sewage Company.

Finally, this will be my last issue as *On Tap* editor. I've accepted the position of publications



photo by Harriet Emerson

Staff and friends of the National Drinking Water Clearinghouse raise a toast of clean, pure water to the 25th Anniversary of the Safe Drinking Water Act. Pictured left to right (first row) Michelle Sanders, Mark Kemp-Rye, Adrienne Kemp-Rye, Kathy Jespersion, Jamie Knotts; (middle row) Mary Stewart, Shekhar Gothoskar, José Fernando Giraldo Rios, Margaret Caigan McKenzie, Babu Srinivas Madabhushi, Mohamed Lahlou; (back row) Bryan Palko, Kairi Frame, Robin Anderson, Dolly Moran, and Betty Golden.

We had no idea our introduction to water tank diving would create controversy, but it has. We've received several letters on the topic. (See page 21.) If you take issue with what we print, by all means, let us know about it.

We'd like to welcome Michelle Sanders, our new graphic designer. Sanders earned a bachelor's degree in English with a television broadcasting emphasis at Waynesburg College, then a degree in graphic design at West Virginia University (WVU). Her specialties include Web design, multi-media, animation, and conference presentation. She most recently worked for WVU at the NASA Facility in Fairmont, West Virginia.

Also, José Fernando Giraldo Rios of Pereira, Colombia, is currently translating the NDWC Tech Briefs into Spanish. He is a participant in the Council for International Programs that places international professionals with WVU departments to learn and exchange information.

supervisor for the Environmental Services and Training Division (ESTD) at WVU. The NDWC is one of four ESTD organizations that include the National Small Flows Clearinghouse, National Environmental Training Center for Small Communities, and the National Onsite Demonstration Programs. I've had the pleasure of editing *On Tap* and working with the NDWC's talented staff since January 1995. Thanks to all of you who have contacted me with suggestions, information, praise, and corrections.

Harriet Emerson  
*On Tap* Editor

## Martins Ferry SCADA System Is Online

by Kathy Jespersen  
NDWC Writer/Editor

*Editor's Note: Three individuals from the National Drinking Water Clearinghouse (NDWC) toured the Martins Ferry water treatment system: Writer/Editor Kathy Jespersen, Technical Assistance Specialist Babu Srinivas Madabhushi, and José Fernando Giraldo Rios.*

Located on the western shore of the Ohio River, and just across the bridge from Wheeling, West Virginia, lies a modest, little town called Martins Ferry, Ohio. Approximately 7,990 people call this small community home, including 17 drinking water treatment plant employees and their system's mascot—Water Dog.

The city's water treatment system has 15,000 customers and 3,900 connections—residential and commercial, including districts to whom they sell water. It produces 2.8 million gallons of water per day (gpd), and it has the capacity to produce 5 million gpd without having to expand the system. From the outside, it appears that there's nothing special about this drinking water system. But once inside, you are immediately taken with the plant's high-tech equipment.

"We went from the Stone Age to the Space Age," says William A. Laughman, superintendent of water, standing in the system's control room. To his right, plant operator John Barkey, sits at a desk facing two computer screens. It almost appears as if he's playing a computer game, but on closer inspection, you can see that he's running the drinking water system, turning water pumps on and off, and checking storage tanks' water levels with the click of a mouse.

### Plant Installs SCADA

The City of Martins Ferry Water Treatment SCADA [Supervisory Control and Data Acquisition] system went online in April 1996. The SCADA system includes two computers, software, a modem, and programmable logic controllers (PLCs).

A SCADA system allows an operator to monitor and control a water system from a central location. The benefits of a SCADA system are most obvious when a process or system occupies a large geographical region. Instead of sending personnel to take readings or make adjustments, monitoring and control of the entire system may be done at one location.

PLCs are often referred to as field devices, and they communicate with a central computer via a communications link, such as a radio, telephone, satellite, or microwave. They send infor-

mation from the remote site back to the control site, where it is displayed on a computer running Human-Machine Interface (HMI) software. Any control signals from the central computer are sent to the PLC.

The Martins Ferry SCADA system runs the entire treatment system, as well as a telemetry system that controls water pumps and monitors water levels in the system's storage tanks. Alarms, which can be viewed on the monitor, notify the operator of low water levels, clogged chemical feeders, or almost anything else that could go wrong. PLCs record and store all information sent and received, which can be printed out and used for recordkeeping or reporting purposes.

If the computer does happen to go down, the system can be operated manually and staff keep a spare PC loaded with the plant's software and information as a back up—just in case. All they need to do is to disconnect the old computer, plug in the new system, reboot, and it's ready to go.

"If the system in the office fails, each individual system has its own computer," notes Laughman. "If those computers fail, we can still operate the system manually. Any part of this system can be overridden and operated without the computer."

### Does the picture tell the story?

The picture that the operator sees on the computer screen is a map of the plant. "We were involved in the design of the [custom-made] screen," says Barkey. "And the final screen suits our purposes."

According to the plant employees, the system architects—ProTech Engineering of Akron, Ohio—took all of their suggestions into consideration during the installation process.

"The engineer put a little button on the screen marked 'notes,' and all we had to do was click on it and type in any changes we thought were necessary," says Bill Suto, the system's maintenance man. "And, sometimes he would get a

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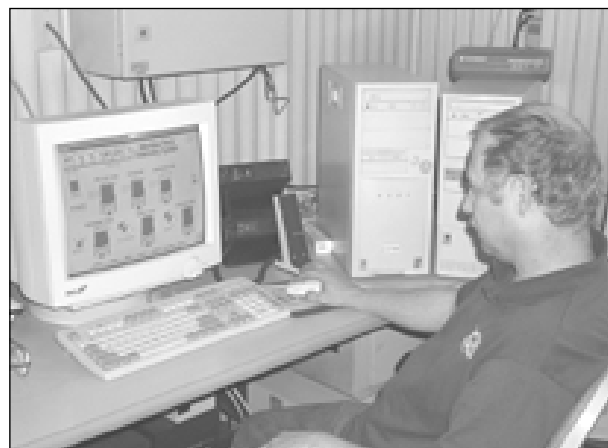


photo by Kathy Jespersen

John Barkey, plant operator for Martins Ferry, Ohio, inspects the water levels of the system's storage tanks from his desktop.



## Martins Ferry SCADA System Is Online

*Continued from page 3*

better idea than what we suggested, but it was still a change that was needed. It's really important that the operators are involved. They really need to sit down with the design people so that they get what they want."

Besides having a screen that is truly functional for this particular system, automation had made operating the system a breeze.

"Everything is set to be done automatically," says Barkey. "If there is an alarm in the plant, a horn will sound and then I can check the screen to find out where the problem is. If there's an alarm in the tank telemetry system, it's generally because someone is using a CB radio on the same frequency, and it interferes with the signal from PLC at that particular tank. The alarm usually only lasts a couple of seconds and then it corrects itself. The PLC tries to call three times and if it can't get through an alarm goes off. The communication signal must be constant."

Being in constant communication with the system helps Barkey get through his day with ease. "I always know how many gallons of water are going through the system," he says. "I can turn a pump on or off from my screen. We don't have to send a man five miles out in a truck just to turn one pump off and another one on.

"It helps with monitoring and reporting because it keeps a history of everything," he continues. "The computer takes care of all the chemical feeds. I just punch a number in and the computer does the rest. I can review all the alarms; everything is charted, which I can print out. It keeps track of all the pumps, and it measures water quality."

### SCADA Saves Time, Money

This system not only saves time, it saves on personnel. "It only takes one operator to run the system," says Laughman. "We have one person on each shift and the plant is staffed 24 hours per day, seven days a week. We also have one maintenance person during the day, but only one person for afternoon and night shifts."

According to Suto, it also changes the way employees work. "We don't have to drive miles out into the country anymore. We can do what we need to do with the tanks from here. It used to be that we just had meters on the wall telling us tank levels, and we never knew if they were accurate.

"If we ever do have a problem with the system, we can call the engineering firm in Akron, Ohio, and he can fix the problem from there," Suto continues. "The engineer doesn't even have to come here. He just calls the computer through the modem, and he can see our system from where he is.

"We've tried to look at the worst case scenarios to learn to operate this plant," says Suto.

"You know, what if this happened or that? It's been trial and error for the most part. None of us knew anything about a computer when this system was installed. But we've read almost every article, newsletter, or book we could get our hands on."

The system's lab technician, Stan Minder, agrees: "We read the operating instructions inside and out. At first it was like trying to learn a foreign language; we've really had to work at learning this system. And we're still tweaking things.

"One time the computer turned everything on," Minder continues. "The place was full of water. I called Bill to come and help me because I was here by myself. We had to go shut everything down manually. So we do know that manual operation is possible. We found out the hard way."

### System Gives Fair Warning

Laughman also warns other drinking water systems considering a SCADA system to make certain that all the software they buy is compatible.

"One of our biggest problems in the beginning was that we were having a hard time getting the vendors of other equipment to work with the software we had," says Laughman.

"We couldn't get the PLCs to talk to each other. And they need to talk back and forth to each other all the time. If there's not much activity on the modem, then you know something is wrong. We had to figure a way to get them all on the same page. The main problem was the PLC on the softening system. It wouldn't talk to the computer. We had to work out the glitches. We sat in the conference room for days trying to work out the problems. But it's all been worth it.

"We are Y2K compliant," says Laughman. "And if anything does happen, I'll just get my calculator out, put a couple of people on overtime, and keep on working."

And if a Y2K problem occurs in the area's electrical service, the system also has an emergency generator, which is capable of running the plant for 72 hours on one tank of diesel fuel. If there's an electrical outage for any reason, the computer senses it and turns on the generator. And every Monday at 8 a.m. it starts up and tests itself.

### System Improves Water Quality

Not only has installing this system saved on manpower and chemicals, it has other more important benefits. One of the biggest benefits has been that the water quality has gotten better.

*Continued on next page*



### RUS Rates

Rural Utilities Service (RUS) water and wastewater loan interest rates for the first quarter of fiscal year 2000 apply to all loans issued October 1 through December 31, 1999. The current rates are:

- poverty line: 3.25 percent,
- intermediate: 4.375 percent; and
- market: 5.5 percent.

Contact the National Drinking Water Clearinghouse at (800) 624-8301 or (304) 293-4191 for the phone number of your state Rural Development office or log onto their Web site at [www.usda.gov/rus/water/states/usamap.htm](http://www.usda.gov/rus/water/states/usamap.htm).

*Continued from previous page*

“Now we get phone calls about how nice the water is,” says Suto. “And that’s kind of nice since we used to get calls about stained white clothing. But the change has been gradual. Some of our customers noticed the change right away, others took awhile. The tanks still had water in them from the old system, and when you first start making new water, it mixes with what’s already there. We had a lot of bugs to work out. So the change was slow at first.”

Iron and manganese are the system’s toughest problems. “You know, if we had a leaky valve, we could just let it go because the leak would eventually seal itself,” jokes Suto. “The water used to be very hard and discolored. The installation of this system has saved many homeowners about \$30 a month in water softening expenses. Hardness in the drinking water is down from 400–450 parts per million (ppm) to 120 ppm for the finished water. Iron is down from 3 ppm to 0.1 ppm and manganese is down from 0.7 ppm to 0.01 ppm. So this is some pretty soft water.”

The treatment system includes ozonation, a traveling bridge filter, and water softening. The source of the water is an underground aquifer that flows south from Lake Erie. The area was also a large coal mining region. And most of the community’s residents were either coal miners or steel workers. In addition, agricultural land surrounds the community.

“We always try to produce more ozone than we actually need because ozonation is the system’s bloodline,” says Suto. “It’s what makes the water potable.”

The traveling bridge filter is the next step that helps turn some very nasty water into a potable water supply. This filter includes a filter bed system, a probe, and a traveling bridge that backwashes the filter layers—anthracite and sand.

“There’s a probe in the filter bed that can measure the water level,” says Suto. “When it gets to a certain point, the system is set up to automatically backwash the filter layers every 14 hours. The automatic backwash tests the water through a turbidity meter before it moves onto the next filter bed.

“This filter has worked from the first day with no problems at all,” he explains. “But

it also has a fail-safe built in. If the filters get too dirty, then the water can’t run them as efficiently. So the probe will measure the water level and will automatically backwash when it’s needed. You can’t have enough backup systems.”

The softening system also has a probe that measures pH. “We now try to discourage people from putting softening systems in their homes because our water is already soft and to soften it anymore could corrode their plumbing,” says Suto.

### System Saves on Chemicals

“We’re saving a lot on chemicals as well,” Suto continues. “We now use about one-fifteenth of the amount of chlorine that we used to use. We used to change the chlorine cylinder everyday, now we change it about once every 15 days. The major saver in this instance has been ozonation. But we’re also using different chemicals that we didn’t use before. One of the nicest differences is that we now have low trihalomethanes.

“We are still learning about how the weather affects the system,” says Suto. “We can see fluctuations in the monitoring that we do. We want to learn how to prevent problems and make changes to the treatment system so we can keep the same quality of water year-round. Cold seems to affect things the most.”

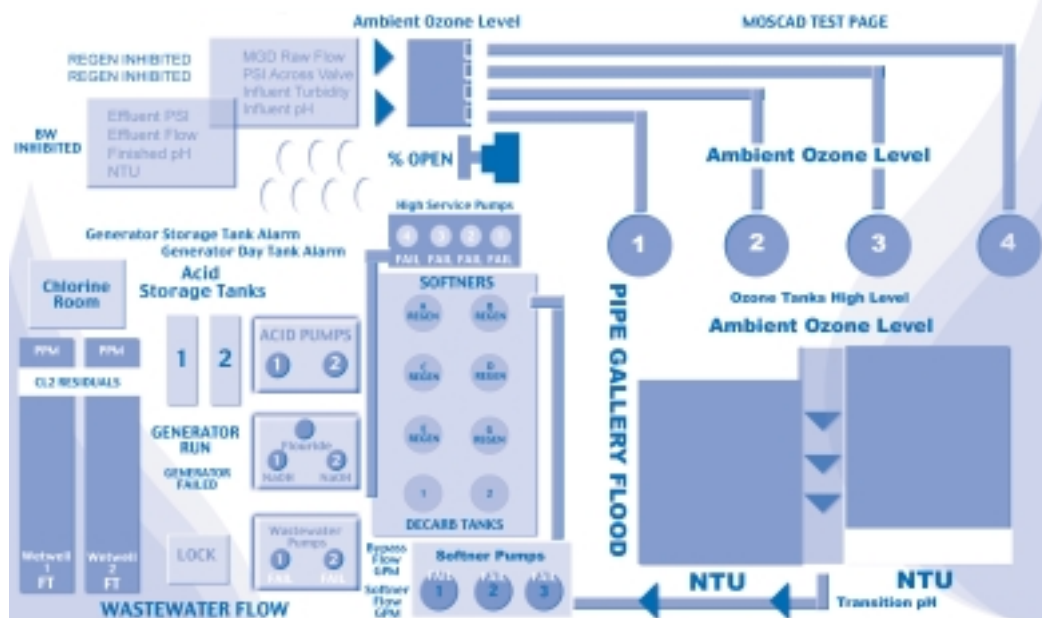
However, finding answers to problems isn’t always easy. So it’s OK to ask for help. “You can’t be bashful about calling up another water system for help,” says Minder. “That’s how we

*Continued on page 6*

“We went from the Stone Age to the Space Age.”

William A. Laughman,  
superintendent  
of water

## MARTINS FERRY WATER TREATMENT PLANT



Running the Martins Ferry Water Treatment Plant is just a mouse click away.

## Martins Ferry SCADA System Is Online

*Continued from page 5*

solved a problem we were having with the softener. It kept clogging. I read an article in a newsletter, and called the system that was highlighted. And we then came up with the hot water injection system that we're using for the sodium hydroxide.

"We also have a first class lab onsite," continues Minder. "We test for pH, fluoride, alkalinity, hardness, iron and manganese, bacteria, and stability. This plant could be set up for really small systems, and it could run without an operator."

### How expensive is it?

"The whole SCADA set-up was less than \$90,000," says Laughman. "The new plant, along with the new water lines and tie-ins with the existing water system, cost \$10.5 million."

According to Laughman, funding for the system was secured through a 2 percent, low-interest hardship loan from the Ohio Water Development Authority (OWDA), and they received an \$118,000 grant from the OWDA to pay the interest during construction.

"Our water rates average \$15.90 to \$26.50 per month," says Laughman. "Residential hookups in town are unmetered, commercial are

metered, and residents outside the city limits are metered. Residential customers who are metered pay an average of \$33.10 per month."

### Pride in Ownership

"We watched the construction of this plant from the ground up," says Minder. "We wanted to know the history of the building so we could know where things were, like pipes, and so forth. This was going to be the place where we would be working, so we wanted to know it inside and out."

Suto sums up feelings for all the employees. "The change in the last few years has been amazing. There's a lot of job satisfaction. We are very thankful for what we have."

*For more information about the City of Martins Ferry Water Treatment Plant, call Laughman at (740) 633-1378. For further information about SCADA system costs, see the Winter 2000 issue of Water Sense.*

*To learn more about treating water with ozone, see "Tech Brief: Ozone" in the center section of this issue of On Tap.*



Water is a bargain:

You can refill an eight-ounce glass of water approximately 15,000 times for the same cost as a six-pack of soda.

Blue Thumb Project

## NDWC Launches Keyword Search Engine

When you're looking for drinking water information, remember that the National Drinking Water Clearinghouse (NDWC) is online. Recently, we added a new keyword search feature to our Web site.

Users may now search for specific drinking water-related topics that were written about in *On Tap* and *Water Sense*, the NDWC's quarterly newsletters. Once users search for a topic, they may download an electronic copy of the newsletter in which the article appeared. Not all newsletters dating back to 1991 are online, however they will soon be available.

In addition to our publications, the NDWC Web site offers water facts, our award-winning groundwater poster, a "what's new" section, and our new product catalog with online ordering. Currently, our most popular items are the Tech Briefs, the drinking water treatment fact sheets published in *On Tap*. Tech Briefs were downloaded more than 2,300 times in the last year.

*To search for specific drinking water information, log onto the NDWC's Web site at [www.ndwc.wvu.edu](http://www.ndwc.wvu.edu).*

## Do you help small communities?

The U.S. Department of Agriculture's Rural Utilities Service funds the NDWC and, as such, we cannot endorse products, nor do we accept advertising in our newsletters—*On Tap* and *Water Sense*. However, we're very interested in new technologies and innovative concepts, and often speak with company representatives or mention specific products in our articles.

If you sell or manufacture a product or offer a service that will save small communities money and improve their water quality or system infrastructure, let us know about it. You greatly increase your chances of discussing your product in our newsletters if you include contacts in at least three small communities.

*Call the NDWC at (800) 624-8301 or (304) 293-4191.*

## RUS Project Officer To Retire

Donna Roderick, project officer for the National Drinking Water Clearinghouse (NDWC) and other technical assistance programs funded through the U.S. Department of Agriculture's Rural Utilities Service (RUS), will retire from the federal government on December 31, 1999, after 30 years of service. Roderick has worked with the NDWC since its creation in 1991.

A native of Maine, Roderick began her career with the Farmers Home Administration (FmHA)—now RUS—in her home state in 1969. She then served in several positions, including county office clerk in Bridgeton, Maine, assistant county supervisor in Bucksport and Westbrook, Maine, and county supervisor in Gardner, Massachusetts.

In 1981 Roderick moved to Washington, D.C., to work as a loan specialist with FmHA. She has been involved with the Technical Assistance and Training (TAT) grant program since its inception in 1988. According to Roderick, one of the reasons that TAT was started was to “protect the billions of dollars the government has invested in water and wastewater improvements by providing technical help to small systems.”


Reflecting on her 30 years with the federal government, Roderick is most proud of the service RUS programs have afforded communities.

“I had the chance to be a small part of helping a whole lot of people,” she says. “It has been a very gratifying experience.

“The NDWC is one of those programs,” says Roderick. “It serves an important function of getting much-needed information about drinking water to the country's small communities.”

Because the NDWC worked so closely with Roderick, her absence will be felt.

“The continuity of having Donna Roderick work with our program has been most beneficial,” says Sanjay Saxena, NDWC program coordinator. “We will miss Donna—and wish her all the best in her future endeavors—and we look forward to continuing our commitment to small community drinking water systems in the year 2000 and beyond.”

Deanna Plauché will be the new RUS project officer beginning January 1, 2000. More information on Roderick and Plauché will be available in the Winter issue of *Water Sense*, the other NDWC publication. 



## E. Coli Contamination Can Cause Illness

*E. coli* 0157:H7 isn't an index reference. It's one of the hundreds of strains of *Escherichia coli* that is an emerging cause of foodborne and waterborne illnesses. While *E. coli* typically lives harmlessly in the intestines of healthy humans and animals, *E. coli* 0157:H7 produces a powerful toxin that can cause severe illness.

The first time *E. coli* was recognized as the cause of illness was in 1982 after an outbreak that was traced to contaminated hamburgers. Since then, most infections are believed to have come from eating undercooked meat. However, some infections have been waterborne. And people have become sick after drinking or swimming in contaminated water.


*E. coli* is a type of fecal coliform bacteria that is found in the intestines of humans and animals. If water is contaminated with *E. coli*, it is a strong indication that sewage or animal waste is responsible. During rainfalls, snowmelts, or other types of precipitation, *E. coli* may be washed into creeks, rivers, streams, lakes, or groundwater. Without proper treatment, *E. coli* can end up in drinking water.

### What are the symptoms?

Infection from *E. coli* can cause severe bloody diarrhea and abdominal cramps. However, there is usually no fever. In some people, especially children under five years old and the elderly, the infection can also cause a condition called hemolytic uremic syndrome, which destroys the red blood cells and causes the kidneys to fail. This is a life-threatening condition that requires blood transfusions and kidney dialysis.

Symptoms of infection usually appear within two to four days, but can take up to eight days. Most people recover without antibiotics in five to 10 days. And there is no evidence that antibiotics improve the course of disease.

Chlorine, ultraviolet light, or ozone all inactivate or kill *E. coli*. Surface water systems are required to treat for its presence.

For more information about *E. coli*, call the Safe Drinking Water Hotline at (877) 372-9283. 





## Water Quality Modeling in Distribution Systems for Small Cities

by Thomas W. Haster, P.E., Associate  
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*Editor's Note: The distribution system discussed in this study is in a larger community than those we usually write about in On Tap (10,000 or fewer people), however, the information is applicable to small systems.*

Historically, water quality modeling has been limited to large skeletonized water distribution systems due to cost, data requirements, and modeling software limitations. This is no longer the case.

Freese and Nichols, Inc., conducted hydraulic and water quality modeling for the City of Brownwood, Texas, (population 20,000) to determine appropriate system improvements. Older developed parts of the city's water distribution system had experienced poor water quality from water line corrosion resulting in a loss of chlorine residual.

### What was the purpose of the study?

The purpose of the water quality modeling was to identify the chlorine content of the water entering the distribution system and how quickly the content decays to a point below regulatory standards. The parameter used to identify the quality of the water in the distribution system is the chlorine residual. Typically, chlorine or chloramine is added to water for disinfection at a water treatment plant to maintain the water quality throughout a distribution system. More and more in water distribution systems, chloramine (a combination of chlorine and ammonia) is used in lieu of free chlorine to minimize the formation of disinfection byproducts, such as trihalomethanes.

The Texas Natural Resources Conservation Commission (TNRCC) publishes minimum water disinfection standards for public water systems in the Texas Administrative Code. These standards state that a free chlorine residual of 0.2 milligrams per liter (mg/l) or chloramine residual of 0.5 mg/l must be maintained throughout treated water distribution systems at all times.

In the near future, TNRCC will publish more stringent water quality standards that will also limit the maximum chlorine residual within a water distribution system to 4.0 mg/l. This will force a significant number of public water systems to make disinfection changes and water distribution system operational changes.

To meet existing disinfection standards, many water distribution systems presently feed high dosages of chloramine (in excess of 4.0 mg/l) at the water treatment plant to overcome poor water distribution systems just to maintain the chlorine residual at or above 0.5 mg/l.

Typical causes of chlorine residual losses in distribution systems include corroded water lines and storage tanks, biofilm buildup in water lines, long dead-end water lines with small water usage, long detention times in storage tanks, and over-sized water transmission lines.

### What are chlorine decay mechanisms?

Previous studies have shown that two primary mechanisms cause chlorine residuals to decay within a distribution system. The first mechanism is bulk decay, which represents the chlorine residual decay that occurs when the chlorine or chloramine reacts with organic or inorganic chemicals within the water. This decay mechanism is totally independent of the water distribution system. As a result, the bulk chlorine

*Continued on next page*

Figure 1  
Chlorine Bulk Decay Rate



The purpose of the study was to pinpoint problem areas and devise a capital improvement program to improve water quality throughout the water distribution system. The steps and constraints involved in conducting water quality modeling for a small city included: a) field testing, b) model calibration, c) hydraulic and water quality modeling, d) capital improvement plan development, and e) verification and operation testing.



*Continued from previous page*

decay can be measured relatively closely under lab controlled conditions.

The second mechanism is wall reaction decay, which represents the chlorine decay that occurs when the chlorine reacts with corrosion or tuberculation within water lines and storage tanks or with biofilms attached to the distribution lines. Tuberculation and biofilms exhibit chlorine demands within a water distribution system. This chlorine demand removes chlorine from the water, which in turn decreases the chlorine residual concentration within the water.

The field testing needed for water quality modeling can be broken down into two areas: the field testing related to chlorine bulk decay and the field testing related to wall reaction decay. Field testing provides the needed information to calibrate the water quality model and to determine which decay mechanism is pre-dominant within a water distribution system.

#### **How was bulk decay measured?**

For Brownwood's water quality study, the chlorine bulk decay was estimated by taking a 5-gallon container of water from the downstream side of the water treatment plant and measuring the chlorine concentration within the 5-gallon container over a period of one month.

Water treatment plant staff took chlorine residual measurements every couple of hours for a month to determine how quickly the chlorine residual decayed. Results indicate that the initial chlorine concentration was approximately 4.25 mg/l. (See Figure 1 on facing page.) After one week, the chlorine residual decayed to 2.75 mg/l. After two weeks, the chlorine residual decayed to approximately 2.10 mg/l. Although significant, these residuals levels are well above the minimum chlorine residual standard of 0.5 mg/l set by the TNRCC.

#### **How was wall reaction decay measured?**

The second step in field testing procedures was to quantify the wall reaction decay caused from corrosion and biofilms within the piping and storage facilities, which required that chlorine residual samples be taken at various locations throughout the distribution system to see how the water quality changed as the water traveled through the distribution system.

Five sampling points were taken throughout the city for first testing. Ten sampling points, including the initial five, were taken throughout the city for testing conducted approximately eight months later.

#### **How were sampling points selected?**

The first sampling point was chosen to identify the water quality entering the distribution system, while the remaining four were selected to represent the various remote areas of the water distribution system. Chlorine residual testing was conducted hourly to see how the water quality changed as water demands changed throughout the day, as well as determining spatial water quality changes throughout the distribution system.

#### **What did sampling show?**

Sampling was performed in April and again in December 1998. Results showed that chlorine residual at the first two sampling points remained fairly constant throughout the testing period at 3.0 to 4.0 mg/l; however, at the third sampling point, chlorine residuals near the courthouse degraded significantly to a point below minimum state regulatory requirements throughout the day as water demands increased.


Sampling point four showed the same general water quality trend as at the courthouse and both of these sampling points demonstrated that the chlorine residual degraded significantly during periods of high water consumption.

The fifth sampling point showed that the chlorine residuals at this location remained fairly constant at a high residual level of 2.75 to 3.25 mg/l.

The initial five sampling points that were retested all showed higher residuals in December, with the first two sampling points ranging between 4.0 and 5.0 mg/l. Sampling point three showed chlorine residuals degrading below the minimum requirement later than in the April testing. And the fourth sampling point showed the chlorine residuals to be much higher than during the April testing, not falling below 2.5 mg/l. The fifth sampling point showed slightly higher in December with a residual ranging between 2.5 and 4.0 mg/l.

The chlorine residual at sampling point six, an industrial park, showed to be fairly constant until it dropped from 2.3 mg/l to 0.5 mg/l in two hours. The seventh sampling point showed fairly high residuals, averaging around 3.0 mg/l. Sampling point eight is located in the downtown area. The chlorine residuals began to fall at 11 a.m. and never rose above 1.0 mg/l after 8 p.m. Sampling point nine maintained a fairly high residual, never dropping below 2.5 mg/l. The chlorine residual at the pump station, the final sampling point, remained constant just below 3.0 mg/l.

*Continued on page 10*



*If every household  
in America had a  
faucet that dripped  
once each second,  
928 million gallons  
of water a day  
would leak away.*

Blue Thumb Project

## Water Quality Modeling in Distribution Systems for Small Cities

Continued from page 9

### What were the results?

The results of the chlorine residual testing throughout the distribution system demonstrated that:

- Chlorine residual levels in the oldest part of the system are significantly worse than the remaining parts of the distribution system.
- Chlorine residuals seem to fall significantly in the evening when there is a high demand throughout the city.
- When demand is low, a majority of the demand is met by water with a high chlorine residual supplied directly from the water treatment plant.
- When demand is high, water is pulled from other areas where the chlorine residual has decayed due to a longer residence time in the system, for example, a booster pump station.
- Computer modeling showed a strong correlation between the direction of flows in the piping network and resulting chlorine residuals.
- Results also indicate that wall reaction decay through corrosion and tuberculation within the old unlined cast iron pipes dominates the water quality degradation throughout the distribution system.

### How was the model calibrated?

The computer model used for the chlorine residual modeling is Haestad's CYBERNET Version 3.1. This hydraulic model uses the EPANET's analytical engine to perform water quality modeling. The EPANET model represents chlorine decay using a first-order rate of decay:  $C(t) = COe^{-kt}$  where  $CO$  is the initial chlorine concentration (mg/l) and  $t$  is time (day). The chlorine decay constant  $k$  (1/day) represents a combination of the bulk chlorine decay and the

chlorine decay associated with wall reactions within the pipeline. The EPANET model allows the user to input two different  $k$  constants representing the two primary decay mechanisms— $kb$  and  $kw$ .

The  $kb$  constant is the decay constant associated with bulk decay, while  $kw$  is the decay coefficient associated with wall reaction decay. The chlorine residual field tests were used to calibrate the water quality computer model. The  $kb$  constant can be approximated numerically using the nonlinear least squares method on the chlorine residual results at the water treatment plant. The resulting bulk decay constant for the City of Brownwood using this procedure was 0.076/day. (See Figure 2 below.)

Once the  $kb$  value is known, the chlorine residual associated with bulk decay can be determined using the first-order rate of decay equation.

The  $kw$  constant is much more difficult to determine as it depends on a number of variables, such as pipe material, pipe age, pipe condition, and storage facilities. For Brownwood, the  $kw$  constant was used as a calibration tool to adjust the water quality model to approximate the field measured data using engineering judgement.

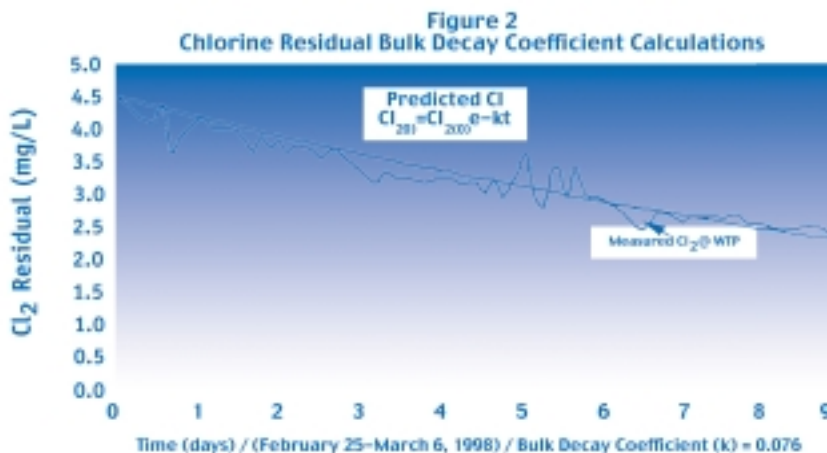
Brownwood water distribution system consists of a variety of pipe materials including polyvinyl chloride (PVC), asbestos, ductile iron, polyethylene, and unlined cast iron pipe. The unlined cast iron pipe primarily existed within the downtown area of Brownwood where much of the existing waterlines are more than 50 years of age. This unlined cast iron piping is where most of the corroded tuberculated pipe exists.

It was decided that the wall reaction decay constant in this downtown area should be significantly higher than in the remaining parts of the city. Therefore, the distribution system was divided into two different zones for assigning wall reaction decay parameters.

The resulting  $kw$  values for the downtown and remaining areas of the city, which matched the field measurements best were -2.0 ft/day and -0.05 ft/day respectively. With the decay constants determined, the next step in the analysis was to conduct the hydraulic and water quality modeling throughout the city to evaluate future system improvements.

### What were the steps in hydraulic and water quality modeling?

The first step in the water quality modeling was to have a well-calibrated hydraulic model with a reasonably accurate distribution of water demands throughout the city. For Brownwood, *Continued on next page*



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all large commercial and industrial customers were treated as point demands with the remaining system demands distributed throughout the city using the various land uses present within the city. It was necessary to run the hydraulic and water quality model as an extended period simulation over a six-day time period. This was necessary to minimize the impact of unknown initial boundary conditions, such as chlorine residuals at remote storage facilities.

The chlorine concentration entering the distribution system from the water treatment plant was held constant at 5.0 mg/l, which matched the chlorine residual sampling at the clearwell. The resulting chlorine residuals throughout the city as determined using the computer analysis indicated that the downtown and remote airport areas were the two primary locations where the water quality degrades to a point below satisfactory.

### **Capital Improvement Plan Is Developed**

Several steps can be taken to improve the water quality concerns in a water distribution system, such as water line replacement, bidirectional flushing, adding booster chlorination stations, and increasing storage turnover. For Brownwood's water distribution system, several pipe coupons (a sliced-out section of pipe) were taken in the downtown area to determine the degree of corrosion and tuberculation within the old water lines.

These coupons showed severe tuberculation within the old unlined cast iron pipes. In locations where existing water lines still have good integrity, it was recommended that the water lines be cleaned to remove the existing tuberculation and lined with cement mortar lining and that the inside of several storage tanks be repainted. This will remove some of the chlorine demand within the distribution system. It was also recommended that several booster chlorination stations be installed at existing storage tanks to improve the chlorine residual levels in the water distribution system.

### **What about verification and operation?**

The verification testing for Brownwood Water Distribution System has not yet been completed since the city is still in the process of constructing water system improvements. Field testing and water quality modeling should be conducted after system improvements are completed to determine the improvements in chlorine residual throughout the water distribution system and to determine how, and at what level, the chlorine booster stations are to be designed.


It is also recommended, as part of the water quality improvements, that water quality sampling points be installed at various locations throughout a city, and that cities begin implementing bidirectional flushing programs in which maintenance staff routinely flush the entire distribution system on a periodic cycle of every two to three years. Another helpful tool in maintaining adequate chlorine residual levels is adding chlorine residuals as an item monitored on the city's SCADA [Supervisory Control and Data Acquisition] systems.

### **What did this study show?**

Results showed that water quality modeling could be conducted effectively for small cities as part of a water distribution system study. The bulk decay parameter can be calculated with reasonable accuracy using field testing, leaving the wall reaction decay parameter as a calibration parameter based on the field data throughout the distribution system. The results also indicated that the flow pattern throughout the distribution system has a significant impact on the resulting chlorine residuals, especially in older corroded pipeline.

*The case study "Water Quality Modeling in Distribution Systems for Small Cities" was delivered to participants of the American Water Works Association (AWWA) 1999 Engineering and Construction Conference "Building the 21st Century Water Works: Are You Prepared?"*

*For a copy of the proceedings on CD-ROM, contact the AWWA at 6666 West Quincy Ave, Denver, Co 80235 or call them at (800) 926-7337. You may also order via e-mail at [bookstor@awwa.org](mailto:bookstor@awwa.org). The cost is \$75 for AWWA members and \$115 for nonmembers. Shipping is \$10 in the U.S. and \$30 outside the country.*

*For further information about the Water Quality Modeling Study, contact the architectural/engineering firm Freese and Nichols, Inc, at 4055 International Plaza, Suite 200, Ft. Worth, TX 76109. You may call them at (817) 735-7300. *

### **References**

1. Boulos, P.F., Moore, M.R. 1997. *Using Hydraulic Modeling to Solve Water Quality Problems*. In Proc. Norfolk: AWWA 1997 Distribution System Symposium.
2. Haestad Methods Inc., *CYBERNET User Manual* Version 3.0. Waterbury, Connecticut: Haestad.
3. Rossman, Lewis A January 1994. *EPANET Users Manual*, Version 1.1. Cincinnati: U.S. Environmental Protection Agency Drinking Water Research Division, Risk Reduction Engineering Laboratory.

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# Tennessee Training Centers Teach Operators

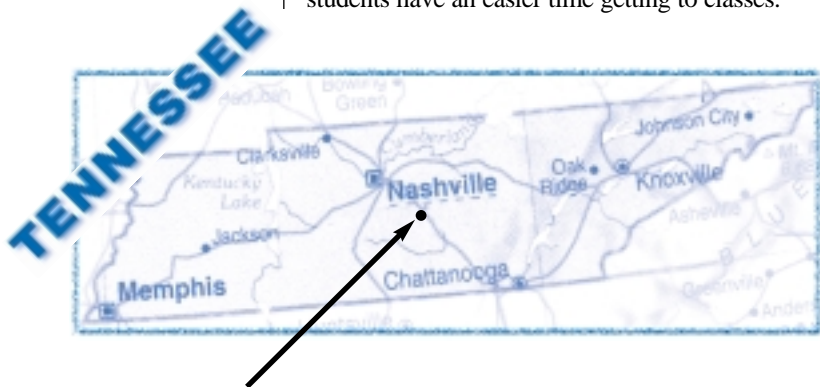
by Kathy Jespersen  
 NDWC Staff Writer/Editor

*Editor's Note: Sanjay Saxena, National Drinking Water Clearinghouse (NDWC) program coordinator, and Kathy Jespersen, NDWC writer/editor, visited both of these training centers in the process of researching this article.*

The Country Music Hall of Fame, the Grand Ole Opry, and Graceland are only a few of the attractions that draw tourists to Tennessee.

But while country music fans may “come to Tennessee because they’re playing our song,” there are two more reasons to be lured to this southern state: the Tennessee Association of Utility District’s (TAUD) Training Station and the Tennessee Department of Environment and Conservation’s Fleming Training Center.

Located in Murfreesboro, which is just south of Nashville, these two facilities are very close to being in the center of the state. Because of their location, students have an easier time getting to classes.



Murfreesboro

Each center offers its own unique training opportunities, such as safety courses, lab classes, and math refreshers. And each turns out highly skilled drinking water and wastewater treatment operators.

### Training Station Opens

“The Training Station opened for business in July 1999,” says Bill Dobbins, executive director, TAUD. “There’s a tremendous need for training, and there’s a lack of training opportunities that both drinking water and wastewater treatment operators need.”

Dobbins says that Tennessee operators must be certified, and that this requirement has been around for years. But he says that regardless of the certification requirement, drinking water and wastewater treatment operators need training because they must be competent.

“What we’ve found is that there’s been a lack of hands-on, performance-based training,” he explains. “There are two training facilities in

this state, but there is a need for different kinds of training. And one place can’t offer everything— but just because we don’t offer it, doesn’t mean it isn’t necessary.

“What we hope for is that our Training Station and the Fleming Training Center can complement each other,” continues Dobbins. “We don’t want to compete. But we want to offer as much training as we can.”

At the Fleming Training Center, Director Brent Ogles explains his center’s philosophy: “We want to train them [operators] so they will have the necessary skills to perform their jobs competently. What they learn will prepare them not only for certification but also for a career. We provide introductory training, as well as advanced classes. Not only do we have a lot of classroom work, we also provide hands-on experience.”

### Training Station Has Many Uses

TAUD’s Training Station is a 7,800-square-foot facility. Approximately 600 square feet are reserved for administrative offices, break areas, and restrooms. The remainder of the building is dedicated to training. The building contains:

- Two multiple-use classrooms that each seat 54 students;
- A 500-square-foot room for computer training classes, which seats 12;
- An approximately 3,000-square-foot open bay for training that requires getting your hands dirty;
- An indoor trench for allowing hands-on training in performing water and sewer line taps, as well as service and fire hydrant installations; and
- Two sewer manholes for confined space training.

The building will serve as TAUD’s base of operations for all of its training programs, including Master Operator, computer training, and training on-call. However, TAUD will continue to provide training outside of middle Tennessee, taking it to wherever it’s needed.

“Beginning in 2000, we want to have at least one training session every week,” says John Shadwick, director of the Training Station. “We also do training on-call. What that means is that we go out to where training is needed for a fee, which is slightly more than a break-even fee. We have other programs that are free of charge, such as those presented through the contract with the National Rural Water Association where the program specialist must go out and supply so many hours of training per year.

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“But we try to make our fee affordable,” he says. “If the system can’t send the operator, then we come to them. Sometimes, daily fees can be split among several small systems. One-day workshops cost \$750 with a \$25 per person fee.”

However, Shadwick points out that sometimes you can’t move the equipment you need to use, so operators have to come to where the equipment is. “Our training is performance based,” explains Shadwick. “When we offered a computer training course that included software for the consumer confidence report (CCR), the systems that came left with their report done.”

classes, we usually have students bring their own lab equipment. Often, you can invest in lab equipment that will be outdated by the next year so we have them bring their own. And practicing with your own equipment makes it easier as well.”

Because certification is crucial to Tennessee operators, Shadwick says that the Training Station offers a course called the Cram Session. “The Cram Session is about 18 years old,” he explains. “Last year, we had 142 attendees. What these sessions do is to prepare them [operators] for the certification exam. We try to get the fear of arithmetic out of them because that’s the biggest reason some people fail. The certification

exam has about a 40 percent pass rate. And of the people who take the Cram Session, the pass rate increases to about 60 to 70 percent.

“We intend no failures,” he says. “But there are two big problems for operators with training: money and time. Hot or cold, no matter what—there’s always some kind of training we’ll have to do out there.”

**Center Has Three Functions**

On the other side of town, the Fleming Training Center has three functions: 1) to provide training classes and seminars for those interested in gaining skills in

the water and wastewater treatment fields, 2) to house the administrative functions of the state’s Water and Wastewater Operator Certification Board, and 3) to provide technical assistance to water and wastewater plants across the state.

The center’s training function provides instruction in a number of areas—not only basic classes in mathematics, operations, and laboratory procedures, but also advanced treatment techniques. Hands-on experience is stressed in topical classes, such as water meter maintenance and repair, leak detection, fire hydrants, filter maintenance, advanced jar testing, and cross-connection control.

The center contains approximately 27,000 square feet, which consists of:

- Two medium-sized classrooms,
- One large classroom,
- A 230-seat auditorium,
- Two laboratories,
- A demonstration area, and
- Various smaller offices and meeting rooms.

*Continued on page 14*



photo by Kathy Jespersen

Lisa Sagman, instructor for water treatment at the Fleming Training Center in Murfreesboro, Tennessee, aids students in a basic math class.

**Classes Require Certification**

“Our classes require certification,” he continues. “It’s an issue of competency. You can take a written test and still not be able to do the task. You have to show that you can do it before you leave the building.”

“Before students take the exam, they have the opportunity to practice under supervision,” Shadwick adds. “But the tester will not coach them during the exam. And they don’t take the exam until they’re ready. However, they also don’t complete the course until they demonstrate the ability—nothing will be handed to them.”

And students will have plenty of equipment with which to practice. “We have \$8,000 to \$10,000 worth of equipment that’s been donated by private industry,” says Shadwick. “We have a number of equipment suppliers.”

“The Training Station is also equipped with trenches for training in line-tapping and other training as well as manholes for confined space training,” he continues. “When we hold lab

*“We intend no failures, but there are two big problems for operators with training: money and time.”*

John Shadwick, director of the Training Station

## Tennessee Training Centers Teach Operators

*Continued from page 13*

Approximately \$75,000 of new laboratory and operational equipment was purchased last year to be used in their classes. Additionally, the center is expanding its offerings to include a number of computer-based resources, such as all major water reference materials on CD-ROM, as well as a number of computer-based operator training courses. These materials are available to anyone wanting to learn more about the water industry.

This fall, the center is partnering with the University of Tennessee Environmental Health Services to offer a series of utility-oriented safety classes. The courses will include emergency response, confined space entry, and personal protective equipment—which will provide the necessary training needed to meet federal mandates.

“We schedule our courses 18 months in advance, and classes are free,” he explains. “We try to make sure that Tennessee’s training and education programs for operators are adequate and up-to-date. A few years ago, when we sent out renewal forms, we included a survey to get operators opinions about training. What we discovered was that, basically, they were pleased with the job we did. Several new classes were suggested, and most of those have been incorporated into our schedule. They also suggested that we try to take our classes on the road more. We have done this by offering several extension classes where five- or 10-day classes are taught off site one day per week for several weeks. Additionally, we now offer several specialty schools, such as leak detection, at smaller plant sites and provide hands-on training experience in the field in real-life situations.

“Mostly, we concentrate on the fundamentals,” he continues. “Our instructors must be able to communicate to a diverse group. Class sizes range anywhere from 10 to about 35 students, and the seminars often have more in them.

“We try to assist them in learning as much as they can to prepare for a career and a certification exam,” says Ogles. “We don’t teach the exam. We want them to know what they need to know to be successful in their chosen field.”

### **Certification Mandated by Statutes**

Most of the center’s certification activities are mandated by statutes and regulations. Currently, the state offers certification in 14 fields of water and wastewater treatment, collection, distribution, and disposal.

According to Ogles, the certification exam is given twice a year on the same day in three different locations across the state. And he hopes that the training operators receive at the Fleming Training Center help them pass the certification exam.

“One thing I heard a lot about when I took this position was that the exam does not reflect what operators need to know,” he adds. “To evaluate this concern, we formed two committees, using people in the industry. They performed a job analysis and formulated need-to-know criteria for each of the certification classes. They then assigned priorities to each subject area and categorized all of our questions. Every question was subjected to a rigorous technical and stylistic review. In some cases, we wrote new or additional questions.

“All of our exams are generated based on this analysis,” Ogles notes. “This is the same thing that the Safe Drinking Water Act is now requiring of all state certification programs. You could say that we were ahead of the game in this area. Although the pass rate is only about 50 percent, operators who take training courses and study do significantly better on the exams. The exams accurately reflect what an operator needs to know. We are very pleased with the tests that we created.”

Ogles also explains that the center conducts seminars for the state’s continuing education requirement. “We [the state] only require five hours of continuing education every three years. This can be accomplished in a one-day class or seminar. All of the center’s seminars and training courses have been approved for continuing education credit.

“We take our continuing education classes to where they’re needed,” he continues. “Even with that, sometimes it’s a struggle for operators of small systems to get there. Often, they don’t have as many resources or opportunities to attend training activities. Their salaries are smaller, travel costs are an obstacle, and it’s harder for them to leave their jobs.”

### **Technical Assistance Provided**

“Our trainers are also technical assistance providers,” says Ogles. “They are all certified water and wastewater operators. Some months they do most of the technical assistance out of the office. Other months most of it is done out in the field. Our instructors must balance technical assistance with training. When classes are in session, field visits must take lower priority.

“We offer training and technical assistance to anyone who wants it,” he adds. “We are unique in that we have this training facility with water and wastewater in the same facility. And that’s a real help. It’s also beneficial that we supply technical assistance to systems who want it.

*Continued on next page*



*“We try to assist them in learning as much as they can to prepare for a career and a certification exam. We don’t teach the exam. We want them to know what they need to know to be successful in their chosen field.”*

Brent Ogles,  
director of the  
Fleming Training  
Center



## Do you want to know more about ozone?

*On Tap* readers also may be interested in proceedings from two international conferences: the 13th Ozone World Congress, 1997, in Kyoto, Japan, and the Regional Conference on Ozonation and Advanced Oxidation Processes (AOPs) in Water Treatment: Applications and Research, in Poitiers, France, 1999.

The 13th Ozone World Congress proceedings are available in three volumes that address a broad range of topics in the area of ozone generation and applications technology. Subjects include: water purification and wastewater treatment processes, reaction mechanisms, transfer and contact systems, advanced oxidation processes, water treatment processes, byproducts, disinfection, and ozone generators.

The section about effects on organisms includes nine papers about ozone in medicine. Also covered are state of the art ozone application in France, Germany, the United Kingdom, Poland, Switzerland, Canada, the U.S., and Japan.

The proceedings from the Regional Conference on Ozonation and AOPs in Water Treatment Applications and Research contains 58 papers covering subjects, such as ozone application in drinking water treatment, cooling water treatments, wastewater processes and other fields; advanced oxidation processes, ozonation contactors, and bromate formation.

*For more information or to order, go to the product section of the International Ozone Association Web site at [www.intozoneassoc.org/ioaweb4.htm](http://www.intozoneassoc.org/ioaweb4.htm).*

## Tennessee Training Centers Teach Operators

*Continued from previous page*

We get a lot of chemical dosage questions, and we try to assist operators in making their systems work better. Wastewater people bring in samples and want to know what kind bacteria is present in it. The good bacteria often determines how well their plants run.

"We stay pretty busy," Ogles says. "We only have a staff of four instructors, and we train between 1,500 and 1,800 students yearly. Our classes run from one day to 10 days in length. Other divisions within our department also use our facility. Occasionally, we have so much going on that we had to park people on the grass.

"I'm thankful for what we've got here," concludes Ogles. "We don't have to pack up equip-

ment and run around with it. And that's a definite plus. We also welcome whoever wants to take the classes. But we don't really advertise that we're here. We hope that word of mouth will generate more student interest."

*For more information about the Training Station, contact TAUD at 840 Commercial Court, Murfreesboro, Tennessee 37129, or call (615) 896-9022. You also may visit their Web site at [www.taud.org](http://www.taud.org).*

*To find out more about the Fleming Training Center, contact the center at 2022 Blanton Drive, Murfreesboro, Tennessee 37129, or call (615) 898-8090. You also may visit their Web site at [www.state.tn.us/environment/dca/fleming.htm](http://www.state.tn.us/environment/dca/fleming.htm).*

## Submit Your System Information to RESULTS

The National Drinking Water Clearinghouse's (NDWC) popular treatment technologies database RESULTS [the Registry of Equipment Suppliers of Treatment Technologies for Small Systems] can be searched free of charge online. And now, operators can submit their system's information online too.

RESULTS is a database containing information about treatment technologies used in small systems, manufacturers/suppliers of technologies, and system contacts. The database offers valuable first-step information for small system owners and operators, design engineers, and others who are exploring treatment technologies for their specific water problems.

For example, a system that needs to treat its water for iron can search the database and find more than 180 other systems that treat for iron. Users can learn about the treatment method used, capital costs of the

plant, maintenance costs, the equipment vendor, and the system's contact information, so they may reach the operator. Database users can evaluate alternative treatment options or compare the costs that other systems expended for their equipment.

Operators can help the NDWC improve the RESULTS database by providing information about their systems. The greater the number of entries in the database, the more useful it will be to users searching for small system information.

*Log onto the NDWC's Web site at [www.ndwc.wvu.edu](http://www.ndwc.wvu.edu) to submit information to the online RESULTS Questionnaire or to search the database free of charge. For those without Internet access, contact an NDWC technical assistant at (800) 624-8301 or (304) 293-4191 to receive a printed questionnaire or to run searches free of charge.*



## What is arsenic?

by Babu Srinivas Madabhushi  
Technical Assistance Specialist

Arsenic (As) is a common, inorganic drinking water contaminant. It is a naturally occurring semi-metal that is tasteless and odorless. Arsenic occurs naturally in the oceans, Earth's crust, rocks, and soil. In drinking water, arsenic exists mainly in two states: As+3 (arsenite) and As+5 (arsenate). The concentrations of arsenic in the Earth's crust range between 2 and 5,000 micrograms per liter or parts per billion (ppb).

Arsenic has long been identified as a toxicant. Previously, arsenic contamination was associated with skin cancer and other disorders, but recent studies suggest that drinking water with high levels of arsenic also can lead to bladder and lung cancer, which are more likely to be fatal.

### What are the sources of arsenic?

As a component of underground rocks and soil, arsenic works its way into groundwater and enters the food chain through either drinking water or consuming plants that have absorbed the mineral.

People also may be exposed from industrial sources, as arsenic is used in semiconductor manufacturing, petroleum refining, wood preservatives, animal feed additives, and herbicides.

Water from wells often has higher concentrations of arsenic than does surface water, such as lakes and streams. The American Water Works Association's (AWWA) National Arsenic Occurrence survey indicates that hard waters contain higher levels of arsenic than soft waters.

In some areas, concentrations in groundwater are elevated as a result of erosion from local rocks. Arsenic also can be found in plants, fish, and shellfish. Mining, manufacturing, and pesticide disposal also can contribute to arsenic contamination.

### How does arsenic contaminate water?

Arsenic can combine with other elements in water to form two types of derivatives (arsenicals): inorganic and organic. In general, inorganic arsenicals are more toxic than organic arsenicals. While food contains both inorganic and organic arsenicals, drinking water primarily contains inorganic arsenicals. For this reason, arsenic contamination of drinking water represents, by far, the greatest hazard. Arsenic can enter water through various ways, such as the dissolution of minerals and ores, industrial effluents, and also from atmospheric deposition. Surface arsenic-related pollutants enter the groundwater system by gradually moving with the flow of groundwater from rains, melting snow, and other types of precipitation.

### How is contamination determined?

A laboratory analysis must be carried out since arsenic is tasteless and colorless. Municipal water systems regularly test for arsenic, and test results can be obtained directly from them. People using private wells must take care of the testing themselves. Tests usually cost from \$25 to \$35.

### Is arsenic regulated?

The allowable concentration of arsenic in potable water has been regulated in the U.S. since the U.S. Public Health Service set a standard of 50 ppb in 1942. The U.S. Environmental Protection Agency (EPA) established the current maximum contaminant level (MCL) for arsenic, 50 ppb, in 1975.

At present, there are very few groundwater supplies in the U.S. that exceed the current arsenic standards. However, there are wells in some parts of the Southwest, and other localized areas around the country that do exceed this standard. Lowering the MCL would, obviously, increase this number of water sources exceeding the standard.

### Why change the standard?

According to Robert Goyer, retired professor, University of Western Ontario, Chapel Hill, North Carolina, "New information on arsenic exposure and cancer indicate that EPA's current standard for acceptable levels of arsenic in drinking water does not sufficiently protect public health." Though additional research is needed, existing data indicate that the MCL should be reduced to ensure that amounts of arsenic in drinking water are at levels that do not pose potential health risks.

"The U.S. Environmental Protection Agency should develop a stricter standard for allowable levels of arsenic in the nation's drinking water supplies as soon as possible," states a new report by a National Research Council committee.

The range of values EPA is currently considering is from 2 to 20 ppb. In the process of setting the new standard, EPA is evaluating the occurrence of arsenic in source waters, the health effects of arsenic, routine monitoring of arsenic by water utilities, and available treatment technologies for removing arsenic from source waters.

In 1996, Congress established certain requirements the EPA must meet in designating a new standard for arsenic. By January 1, 2000, the new water standard will be introduced, and by January 1, 2001, the final arsenic rule will go into effect. This gives sufficient time for the water systems to take significant steps to reduce arsenic from their drinking water supplies.

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*Continued on page 18*

### **How does it affect the human body?**

Arsenic is readily absorbed from the gastrointestinal tract into the blood. The mechanisms through which arsenic causes cancer are not well understood, but the existing data indicate that arsenic probably causes chromosomal abnormalities that subsequently cause cancer. Sensitivity to arsenic's effects is very subjective, varies from one individual to another, and appears to be influenced by factors such as nutrition and genetics.

### **What are the effects of contamination?**

Consuming food and water are the major sources of arsenic exposure. Arsenic-related health problems are prevalent in Asian countries.

Health effects from consuming arsenic-contaminated drinking water are delayed. Skin lesions generally appear first but only after a minimum exposure of approximately five years.

Daily consumption of water with greater than 50 ppb of arsenic, which is less than one percent of the fatal dose, can lead to problems with the skin, and circulatory and nervous systems. Hyperpigmentation, depigmentation, keratosis, and peripheral vascular disorders are the most commonly reported symptoms of chronic arsenic exposure. If arsenic builds up to higher toxic levels, it may cause organ cancers, a number of internal cancers, and neural disorders.

Consumption of arsenic-contaminated water may cause stomach pain, nausea, vomiting, diarrhea, numbness in hands and feet, partial paralysis, and blindness.

Studies show that in addition to causing skin, bladder, and lung cancer, consuming arsenic can also cause skin lesions, anemia, nerve damage, and circulatory problems. New data and models for estimating risk indicate that the likelihood of developing cancer from drinking water that contains the maximum allowable amount of arsenic greatly increases when lung and bladder cancers are included.

### **How is arsenic removed from water?**

Fortunately, there are many technologies available for arsenic removal. The list includes coagulation/filtration, lime softening, ion exchange, activated alumina, and membrane processes, such as reverse osmosis (RO), nanofiltration (NF) and electrodialysis. Pretreatment may be needed in some cases to ensure acceptable treatment by the primary unit.

The selection of treatment technology is critical, however, as it should not affect the rest of the treatment process. According to EPA's Arsenic Research Plan, these technologies are effective for the current MCL of 50 ppb of

arsenic, but if the MCL is lowered, further research must be carried out to determine the effectiveness of these technologies.

For drinking and cooking, water can be treated through distillation, deionization, or RO if arsenite is first oxidized into arsenate. Some studies have shown that conventional treatment with aluminum and iron salts can be used to remove arsenic from drinking water.

One simple option is to blend waters high in arsenic with water low in arsenic content, or to oxidize the arsenic to arsenate form, and then remove it with conventional alum or iron coagulation, or by the lime softening process. But, these conventional methods may not be sufficient if the MCL is lowered to 2 ppb.

Studies have shown that RO is generally effective in removing arsenic from source water. Laboratory studies indicate RO membranes reduce arsenic by almost 70–90 percent. The effect of pressure and temperature on arsenic removal needs to be studied further.

One 1997 study by Waypa *et al* indicates that, contrary to general notion, high removal efficiencies can be obtained for As+3 also, using RO and NF. This will prove beneficial for treating groundwater, in which arsenic is present in As+3 state. Pretreatment of water may be required to avoid membrane fouling.

NF has proven to remove just about any harmful material from drinking water. However, at this time, this technology also removes all non-harmful material as well, leaving it tasting like distilled water.

Manganese greensand filtration is also an option. A study in Canada used potassium permanganate as a pre-oxidant followed by manganese greensand filtration. Arsenic removal was in the range of 90–98 percent. To remove organic arsenic, granular activated carbon filtration can be added.

Some treatment technologies may not be amenable to point-of-entry, whole house treatments. In these cases, point-of-use units may be the best option. New types of treatment technologies, including co-precipitation treatment, ion exchange, activated alumina filtration, and chemical packages for household treatment, are being tested. Some studies have reported preliminary successes in using packets of chemicals for household treatment. Some of these can be used for arsenic removal in conjunction with disinfection.

### **References**

1. *Office of Research and Development Research Plan for Arsenic in Drinking Water*. 1998. National Center for Environmental Assessment. Cincinnati: U.S. Environmental Protection Agency (EPA/600/R-98/042).

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## A Brief History of Drinking Water Regulations

*Continued from page 1*

The year 1925 brought an update to the drinking water standards. PHS first instituted a limit for bacteriological counts. They also set limits for physical and chemical levels for lead, copper, zinc, and excessive soluble minerals.

The PHS again revised drinking water standards in 1942, 1946, and in 1962. These revisions spelled out guidelines for methods of bacteriological sampling and set maximum permissible concentrations for such substances as arsenic, fluoride, lead, selenium, and copper. All told, 28 constituents were covered by the standards.

Pontius notes that the standards were limited in ensuring safe drinking water for the public. Only those 700 or so water systems that supplied water to interstate carriers—fewer than 2 percent of water suppliers—had to abide by the federal rules.

### **Concern Arises over Water Quality**

By the late 1960s, economics, population, and industrial growth increased the need for more water. By necessity, communities often drew raw water from polluted sources. News articles appeared in the *Washington Post*, the *New York Times* and other publications concerning the quality of the nation's public water supply.

In 1970, the PHS released results of its Community Water Supply Study (CWSS), which painted a disturbing picture of the public's water supply. The study looked at whether water systems met the 1962 PHS standards, and of the 969 public water systems surveyed, 41 percent did not. And it concluded that eight million Americans were drinking substandard water.

In addition, the study indicated that systems, particularly small ones serving fewer than 500 customers, had problems with source water protection, disinfection, clarification, and distribution system pressure.

In the early 1970s, researchers discovered that chlorine reacts with organic material in water during disinfection to form a class of compounds referred to as trihalomethanes (THMs) or disinfection byproducts (DBP). The health effects of these DBPs were unknown at the time and led to concern for the public's safety. (For more information about THMs, see the Spring 1999 issue of *On Tap*.)

### **Congress Gets Involved**

Interest in public drinking water safety mounted in the early seventies as questions continued to be raised about water safety. The CWSS report increased public and legislative interest. Congress began to examine legislation that would allow the federal government to set maximum contaminant levels (MCL) permissible in drinking water. Congress held hearings in 1971, 1972, and 1973—but legislation died.

After four years of committee work, Congress enacted the SDWA in 1974 and authorized EPA to set standards to protect users from any contaminant in public water systems that may have adverse health effects.

### **What did the 1974 Act require?**

The new regulations stipulated that EPA develop new national standards, oversee special studies and research, and guide implementation. EPA required all public water systems to comply with health standards it issued, but regulations did not apply to noncommunity water systems serving transient populations.

EPA adopted the National Interim Primary Drinking Water Regulations in December 1975 and later proposed a revised set of regulations based on a study of the health effects of drinking water contaminants.

*Continued on next page*

## What is arsenic?

*Continued from page 17*

- Scott, K.N., Green, J.F., Do, H.D. and McLean, S.J. April, 1995. "Arsenic Removal by Coagulation," *Journal AWWA*, pp: 114–126. Denver: American Water Works Association.
- Waypa, J.J., Elimelich, M., and Hering, J.G. October 1997. "Arsenic Removal by RO and NF membranes," *Journal AWWA*, pp: 102–114. Denver: American Water Works Association.
- Hunt, J. October 1997. "Dealer develops simple, reliable treatment method," *Water Conditioning and Purification*, pp: 104–107.
- Ellis, R.W. January 1997. "Manganese Greensand Filtration," *Water Conditioning and Purification*, pp: 54–57.
- Clifford, D. and Lin, C.C. 1991. *Arsenic removal from drinking water in San Ysidro, New Mexico*. Cincinnati: U.S. Environmental Protection Agency Risk Reduction Laboratory (EPA/600/S2-91/011).
- Eaton, A.W. February 1994. "Determining the practical quantitation level for Arsenic," *Journal AWWA*, pp: 100–114. Denver: American Water Works Association.

- McNeill, L., and Edwards, M. May 1997. "Arsenic removal during precipitative softening," *ASCE Journal of Environmental Engineering*, pp: 453–460. Reston, VA: American Society of Civil Engineers.
- Analytical Chemistry of Arsenic in Drinking Water [Project #914] ([www.awwarf.com/exsums/914.htm](http://www.awwarf.com/exsums/914.htm)).
- Arsenic Information ([www.lcse.umn.edu/~jolson/groundwater/arsenic.html](http://www.lcse.umn.edu/~jolson/groundwater/arsenic.html)).
- Arsenic Reduction Systems ([www.krudico.com/arsenic.htm](http://www.krudico.com/arsenic.htm)).
- Arsenic affects the whole body, A report on Medical Survey in West Bengal, India ([www.kfunigrac.ac.at/twiwww/aan/news11/affects.html](http://www.kfunigrac.ac.at/twiwww/aan/news11/affects.html)).
- Frequently Asked Questions about Arsenic ([www.wellowner.org/arsenic.htm](http://www.wellowner.org/arsenic.htm)).
- Cancer risk from Arsenic highlighted in NRC Report ([www.unisci.com/stories/19991/0326991.htm](http://www.unisci.com/stories/19991/0326991.htm)).
- "EPA Needs more stringent standard for Arsenic in Drinking Water," National Academy of Sciences. ([www4.nationalacademies.org/news/nsf/](http://www4.nationalacademies.org/news/nsf/)).

*Continued from previous page*

New regulations recommended maximum contaminant levels (RMCL) set to prevent known or anticipated health effects. The RMCL, subsequently referred to as the maximum contaminant level goal, acted as a goal rather than an enforceable regulation. EPA did establish a set of federally enforceable regulations called the MCLs.

By the late 1970s, EPA set standards for six pesticides; turbidity; THMs; radionuclides; and inorganic, organic, and microbiological contaminants. By the early 1980s, 23 contaminants were regulated.

### **Changes Are Made in 1986**

In 1986, the SDWA was reauthorized and significantly changed, in part because EPA was unable to develop regulations in a timely manner. In the 1986 amendments, Congress listed 83 contaminants—including 22 EPA had already set—and required EPA to establish or revise standards for each contaminant within three years.

In addition, after the standards for the initial 83 were set, EPA was required to add 25 contaminants—although this requirement was not met—to the list every three years. This requirement raised concerns about unfunded federal mandates—in particular, what the impact of meeting regulations would be on local drinking water systems without the accompanying federal dollars to help systems meet the requirements.

Other requirements that took effect included a ban on lead pipes, solders, and flux; disinfection in all public drinking water, new wellhead and sole source aquifer protection programs; and recommendations for best available technology for treating regulated contaminants.

### **SDWA Is Reauthorized Again**

In 1996, Congress reauthorized the SDWA and repealed the requirement that EPA regulate 25 new contaminants every three years. Instead, they established a process to select and regulate contaminants that pose the greatest risk to the public health, using risk assessment and cost-benefit analysis. The change was made to correct problems EPA faced in trying to implement

the 1986 amendments. Many small systems found it difficult to afford expensive laboratory tests for what some considered exotic chemicals.

Congress focused on four major reform themes in the 1996 Amendments:

- new funding for communities and states through a drinking water state revolving fund to provide infrastructure capital;
- a focus on preventing problems, not merely on correcting them once they occurred, using such tools as operator certification and source water protection;
- regulatory improvements that included better science, assessing the risk of contaminant exposure, and a cost-benefit analysis when national primary regulations are proposed; and
- better information for consumers through annual Consumer Confidence Reports.

### **EPA Meets Deadlines**

Implementation of the 1996 SDWA is progressing. EPA has kept pace with its deadlines. A summary table of statutory requirements in the SDWA Amendments of 1996 and other related deadlines may be found at [www.epa.gov/ogwdw/sdwa/sdwa.html](http://www.epa.gov/ogwdw/sdwa/sdwa.html). You can also view a list of actions EPA has completed through links on the site.

“In 1996, the Administration and Congress gave the American people a sensible and comprehensive law to protect public health,” stated J. Charles Fox, EPA Assistant Administrator, Office of Water, in a Senate oversight hearing March 3, 1999. “EPA and its partners have created a framework that embodies the principles of the 1996 Amendments, and developed many of the tools necessary to provide cost-effective public health protection into the 21st Century.”

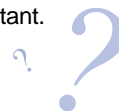
*For a more extensive look at the SDWA through the years, read Frederick W. Pontius' History of the Safe Drinking Water Act online at EPA's Web site [www.epa.gov/safewater/sdwa25/sdwa.html](http://www.epa.gov/safewater/sdwa25/sdwa.html). You may phone Pontius at (303) 986-9923 or e-mail him at [pontius@polnow.net](mailto:pontius@polnow.net).*

## Need answers to your drinking water questions?



The National Drinking Water Clearinghouse's (NDWC) technical assistants are available to answer questions about drinking water issues such as specific regulatory requirements, financing methods, contaminants, and how to treat water quality problems.

If you have a drinking water-related question and don't know where to turn, call the NDWC at (800) 624-8301 or (304) 293-4191 and ask to speak with a drinking water technical assistant.





## Letters to the Editor

*Dear Editor:*

Concerning the article in *On Tap*, Summer 1999, Volume 8, Issue 2, I take issue with some of the comments put forth by Wayne Dykstra, president of Liquid Engineering, Billings, Montana; and by Michelle Moore, author of the article.

I do agree with several of the points raised, such as who is qualified to inspect water storage tanks, and about the Occupational Safety and Health Administration (OSHA) compliance for water tanks.

Some of the items that should be addressed, in addition to the ones raised, are:

- Is a remote controlled submersible vehicle preferable? In many cases it can achieve satisfactory results without the requirements of OSHA.
- Is your dive inspector trained and knowledgeable in OSHA compliance regarding fall protection?
- Is your dive inspector knowledgeable regarding operations of a water storage tank?
- Is your dive inspector an engineer?
- Is your dive inspector a NACE [National Association of Corrosion Engineers] Certified Coating Inspector?
- Is your dive inspector an AWS [American Welding Society] Certified Well Inspector?
- How long has the diving contractor been involved in inspection of water storage tanks?
- What type of track record does the dive inspection firm have with past project?

Mr. Dykstra says that commercial divers should never be confused with SCUBA divers. First of all, many commercial divers do use the SCUBA diving system, which is simply an abbreviation for Self-Contained Underwater Breathing Apparatus. Also, SCUBA, while possibly not appropriate in every situation, versus an umbilical and hard hat, does keep the diver from causing turbidity in the water system.

Videotaping is an excellent visual record of the dive, but turbidity cannot be monitored with the camera on the head of a hard-hat diver when he is looking forward and not toward his feet. The utilities will not be able to document the turbidity at the foot elevation, or turbidity caused from walking on the floor area of the tank behind the diver. An advantage with SCUBA divers is they can achieve neutral buoyancy, thus not causing turbidity problems.

I do agree with Mr. Dykstra that recreational diving programs and certifications should not be a baseline qualification for a dive inspector. There are many facets and many hours of training required to achieve competence as a confined

space potable water storage tank dive inspector. Mr. Dykstra also states that five divers over the last seven years have been killed in diving accidents all of them were using scuba equipment, and four of the five were only sport certified divers.

Mr. Dykstra does not list if any members of the Association of Diving Contractors (ADC), which he advocates as a standard in the industry, were involved in any of the accidents. And, if umbilical hard-hat diving is preferable, why were those ADC members using SCUBA equipment?

Mr. Dykstra also does not list the U.S. Navy qualifications for training and advocates that only ACDE [Association of Commercial Diving Educators] commercial dive training certification is valid. I take issue with that because ACDE training is the direct offshoot of the U.S. Navy training.

To close, any utility that is considering a dive inspection needs to think about:

1. What they want to achieve in the inspection and if a dive inspector is the correct-procedure versus a total drained and dry inspection.
2. The utility also should be concerned that the dive contractor follows state, local, and federal regulations as far as maintaining the quality of water and safety of personnel involved in any inspection. Dive inspections are very specialized.

Finally, as Mr. Dykstra stated—"just because you can go out and buy an airplane or a fire truck does not mean you are automatically a pilot or a fireman." I would like to state that because you have received ACDE commercial dive training, it does not make you a potable water storage tank inspector following all confined space requirements regulated by OSHA.

*Curtis Peacock,  
Project Manager/Inspection Services  
Dixon Engineering and Inspection Services  
For The Coating Industry*

*You may write to Dixon Engineering and Inspection Services For The Coating Industry at 1104 Third Ave., Lake Odessa, MI 48849 or call them at (616) 374-3221.*



## Letters to the Editor

*Dear Editor:*

Having reviewed Mr. Peacock's comments on the recent *On Tap* article "Is there a diver in your tank?" I would have to agree with virtually all of his comments. Unfortunately, due to the space limitations in the original article, many of my comments and observations were taken out of context or edited in a manner that may have led to some confusion. With respect to those issues raised by Mr. Peacock, the first is "SCUBA divers." The two specific issues involved with the use of SCUBA [Self-Contained Underwater Breathing Apparatus] are diver qualifications and the equipment.

Mr. Peacock and I both agree that the "sport" diver certifications do not provide an adequate level of either training or technical expertise to safely conduct technically valid potable water system diving work. While appropriate Navy or ACDE [Association of Commercial Diving Educators] training may provide satisfactory training, neither of these agencies provides the necessary technical background to adequately ensure a recognized and repeatable investigation. That technical expertise can only be gained through education, training, and experience. With that in mind, we have made the commitment to having licensed structural and civil engineers on staff, to provide this technical expertise to our clients, as well as the best possible training for our divers.

As for diver equipment, AWWA [American Water Works Association] specifically allows the use of SCUBA in potable water tanks. Unfortunately, this policy is in direct contradiction to existing OSHA [Occupational Health and Safety Administration] regulations that mandate the use of hard hats in confined spaces, or areas where the possibility of head injury to a worker may occur. This has been confirmed many times by Anthony Brown, OSHA Director of Construction Regulation, in Washington, D.C. OSHA's position is that because divers are involved does not exclude them from other existing OSHA regulations.

I'm sure that Mr. Peacock or his employees do not work in "dirty" water tanks or around plumbing, piping, or valves without wearing a hard hat. If that is indeed the case, what affords "special protection" to divers from these same intrinsic hazards? As an employer, I cannot in good conscience allow my employees to be exposed to hazards that can be easily mitigated by spending a few more dollars for the proper protective equipment—this is best provided by the use of commercial "hard hat" gear.

With respect to the Association of Diving Contractors (ADC), I only referenced this group

because I don't know of any other diving organization that has made any effort to develop a standardized set of safe commercial diving policies and standards, as well as promulgate a set of potable water diving standards. My company has developed policies and procedures that greatly exceed OSHA, AWWA, and even ADC's standards, because we feel that these standards fall far short of the minimum requirements that are necessary in this arena.

As for turbidity, I agree completely with Mr. Peacock's observations. That is why Liquid Engineering Corporation divers routinely inflate their dry suits, the same way a SCUBA diver inflates his buoyancy compensator to achieve neutral buoyancy. Further, our diver umbilicals are specifically constructed to float on the surface of the water, as opposed to dragging them across the floor of a reservoir.

On the issue of fatalities, one of the diver deaths I mentioned did indeed involve an ADC member. First, the diver in question was equipped with SCUBA and second, there is some question whether the dive team involved was following ADC standards and policies. The diving contractor received a number of expensive fines from OSHA for violations.

It certainly was not my intent to suggest that ADC members are "magically" better divers or companies than non-members. My point was precisely the opposite. There are dozens of divers who are seriously injured and killed each and every year—many of them are ADC member employees (offshore oil industry, etc.). Unfortunately, in our niche, potable industry—and given the tens of thousands of safe reservoir diving incursions that occur every year—it is very easy to become complacent and ignore the fact that every single water tank dive has hundreds of opportunities for a catastrophic result (head injury, slips, falls, etc.)—even ignoring the hostile marine environment itself.

Hopefully, this will address the issues raised in Mr. Peacock's letter in a satisfactory manner. As we all know, safe diving and technical inspection competence are the result of proper credentials and training, adequate preparation, and careful planning, regardless of the company undertaking the work.

*Wayne Dykstra, President  
Liquid Engineering Corporation*

*You may write to LEC at 2484 Overland Ave., Billings, MT 59102 or call (800) 438-2187. You may also log onto their Web site at [www.lemail@liquidengineering.com](http://www.lemail@liquidengineering.com).*





## Reader Responds to Tank Diving Article

*Editor's Note: This is a condensed version of a letter by John Conrady, P.E., Conrady Consultant Services, Vero Beach, Florida, which may be viewed in its entirety on our Web site at [www.ndwc.wvu.edu](http://www.ndwc.wvu.edu). Please note that Wayne Dykstra did not have an opportunity to respond to this letter.*

John Conrady took issue with a number of items in "Is that a diver in your tank?" He believes that portions of the article were "seriously incorrect and misleading" with respect to the current 1910 OSHA [Occupational Health and Safety Administration] Commercial Diving Standards Subpart T "Commercial Diving Operations," as well as with the existing AWWA [American Water Works Association] C652-92 Standard.

Conrady says that information in the article may encourage *On Tap* readers to avoid soliciting bids from companies that have been safely conducting underwater storage facility inspections for years. He also says that the article infers that a utility or company should only use certified members of the Association of Diving Contractors (ADC).

He explains that the only existing "Commercial Diving Certification" is from the ADC, which is obtained by joining and paying yearly dues. Consequently, many commercial diving companies don't belong to ADC. He further notes that anyone who completes an Association of Commercial Diving Educators (ACDE) approved commercial dive training program is still ineligible to obtain an "ADC commercial diver certification" unless they join ADC and become yearly dues paying members.

Also, ADC has specifically made provisions to certify divers where documented evidence of qualifications and experience in commercial diving exists—instead of completion of an ACDE program—if they join ADC and become yearly dues paying members.

However, he states that there is no such thing as a "certified commercial diver" per OSHA 1910. The regulation states, "Each dive team member shall have the experience or training necessary to perform assigned tasks in a safe and healthful manner" and does not require or establish a "Commercial Diver Certification."

He also says that the article indicates that "commercial divers" do not use SCUBA (Self Contained Underwater Breathing Apparatus) equipment, such as compressed air cylinders, masks, and regulators, and that divers who do use SCUBA equipment are not "commercial divers."

But he notes that the OSHA SCUBA diving regulation specifically identifies the procedures

to be followed when using SCUBA equipment for "commercial diving" purposes—and specifically allows the use of masks.

According to the article, the diver also must be totally encapsulated in a dry diving helmet, a dry suit, and must use surface supplied air. However, the revised AWWA C652-92 Section 5.4.1 Equipment and Clothing, Subsection 5.4.1(a) states that both SCUBA and externally supplied air methods are acceptable air sources. The standard states, "... The head shall be fully encapsulated by one or a combination of the following: helmet, dry suit hood, or full face mask."

Conrady also says that the article gave the impression that conducting an underwater inspection is an extremely hazardous operation. He states that only six recorded deaths have occurred in water storage facilities during 40 or more years of non-military diving. He says that no diving accidents, injuries, or deaths have been recorded by any of the companies that specialize in conducting the underwater inspection in the last 10 or more years. Conrady estimates that utility employees, utility boards, or other untrained individuals inspect 200 to 500 water storage facilities each year, using common recreational equipment.

According to the article, OSHA diving regulations specify that there must be a minimum three-man team and that all must be fully qualified divers. However, 1910 OSHA Commercial Diving Standards Subpart T states: "For the underwater inspection of water storage facilities, if the diving operation is conducted in a water depth of 100 feet or less, and the inspector utilizes a surface supplied air system, the minimum manpower requirement is two persons, one diver and one dive tender, and a standby diver is not required."

This would change to three persons, including a standby diver, only if a SCUBA bottle is used for the inspection instead of a surface supplied air system

AWWA C652-92 Standard Section 5 Subsection 5.4.2 Personnel Requirements states: "It is recommended that the dive team performing the work should include a minimum of two SCUBA -certified divers (one being a standby diver), each with diving experience in closed confined spaces, and experience in the use of the underwater inspection equipment. Unless otherwise specified by the purchaser, the standby diver need not be suited up and, in case of emergency, is not required to undergo disinfection procedures before entering the water-storage-facility."

According to the Standard revision, which is not in effect and still being debated, the dive  
*Continued on next page*



## MATAC Provides Assistance to Small Systems

Realizing the difficulties small systems face with regard to capacity development, the reauthorized 1996 Safe Drinking Water Act (SDWA) provides for regional university-based Technical Assistance Centers (TACs) that provide training, education, and technical assistance to public water systems. (See the Fall 1999 *On Tap* for more information about TACs. See the Fall 1998 *Water Sense* for more information about capacity development.)


The Mid-Atlantic Technology Assistance Center (MATAC) is one such center. Housed within the Maryland Center for Environmental Training (MCET) and located at the Charles County Community College, MATAC provides no-cost evaluations of small water systems, using a capacity development approach.

“Our evaluators look at all aspects of a water system,” says Frank Comstock, MATAC project coordinator, adding that evaluations delve into production, treatment, and distribution of water.

Other MATAC services include taking an in-depth look at maintenance practices and management controls, and exploring a system’s present and future financial viability.

After the assessment, MATAC provides a detailed report identifying current operations, maintenance, management, and financial health of the system, making recommendations for meeting current and future SDWA requirements—including fulfilling future financial obligations.

MATAC provides assistance to small drinking water systems in Maryland, Virginia, West Virginia, Pennsylvania, Delaware, and New Jersey.

For more information about MATAC, write to the Maryland Center for Environmental Training, 8730 Mitchell Road, La Plata, Maryland, 20646-0910. You may also call (301) 934-7546 or visit their Web site at [www.mcet.org/specproject/matac.htm](http://www.mcet.org/specproject/matac.htm). 

## U.S. Water Prices Getting Cheaper

Is water getting cheaper? It’s true, according to a news story on the *Water and Wastewater International* Web site. The story notes that the cost of water dropped an average of 0.5 percent to just under 51 cents per cubic meter, reports the latest 1999 NUS International Water Cost Analysis.

Richard Soutanian, Co-President of National Utility Service (NUS), Inc., notes that one of the greatest price drops was in Newark, New Jersey, where consumers received a reduction of almost seven percent.

“In contrast, prices rose three percent in Los Angeles, California, over the past year, one of the few rises for the year,” says Soutanian.


The story notes that this is good news for inflation, but warns that the situation could soon change, following the recent drought and floods. Other highlights from the NUS International

Water Cost Analysis include:

- German consumers pay the most for their water;
- South Africa posted the greatest price increase (9.8 percent);
- Finland consumers obtained the greatest price decrease (down 2.3 percent); and
- Canada’s water prices remain the cheapest surveyed.

The annual survey is part of NUS’s utility cost management work to help organizations obtain better utility prices.

For more information about the survey, contact the NUS at One Maynard Drive, Park Ridge, New Jersey 07656. Or call (201) 391-4300.

Information about other surveys is also available on their Web site at [www.nusinc.com](http://www.nusinc.com). 

## Reader Responds to Tank Diving Article


*Continued from page 22*

team should consist of two “qualified” (not certified) divers and a third person should be present for the inspection who is required to be certified in CPR and First Aid.

Since January 1982, Conrady has been in the business of inspecting water storage facilities. He worked with EPA and AWWA to establish a disinfection procedure for inspections that was accepted and approved by both organizations. He is currently a member of the AWWA

C652-92 Standard Disinfection of Water Storage Facilities” subcommittee that is working on revisions to existing standards.

To learn more about OSHA regulations visit [www.osha-slc.gov/OshStd\\_data/1910\\_0424.html](http://www.osha-slc.gov/OshStd_data/1910_0424.html). AWWA standards are available at [www.awwa.org/awwastds.htm](http://www.awwa.org/awwastds.htm).

You may write to Conrady Consultant Services, Box 650948, Vero Beach, Florida 32965-0948 or call (561) 562-1117. 

**Features**

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**SDWA, Distribution System Products Available**

*Note: The free items listed below are limited to one of each per order. Call (800) 624-8301 or (304) 293-4191 to order products and to verify prices. Please allow three to four weeks for delivery. Actual shipping charges are added to each order. National Drinking Water Clearinghouse (NDWC) products also may be ordered via e-mail at ndwc\_orders@mail.estd.wvu.edu. Products are subject to availability.*

■ **On Tap, Winter 1996**  
Item #ONTAP20

This special Safe Drinking water Act (SDWA) reauthorization issue explores the impacts the act will have on small drinking water systems.



■ **Impact of Pipe Coatings on Drinking Water Quality**  
Item #DWBLRE01

This booklet presents case studies of trace chemical contamination in the City of Calgary's distribution system. In most cases, it was observed that the cause of the contamination was the internal pipe coating material. Results suggest that proper and careful selection of the pipe linings and testing are required to provide safe drinking water.

■ **Safe Drinking Water Act Pocket Guide and 1996 Amendments**  
Item #DWPKRG25—1996

This booklet is designed specifically for the owners and operators of small water systems. It explains the SDWA in clear and understandable terms. It also provides the 1996 amendments to the SDWA.

■ **Standardized Costs for Water Supply Distribution Systems: Complete EPA Report**  
Item #DWBKDM19—1992

This report includes cost data for construction, operation, and maintenance of domestic water distribution pipelines, water pumping stations, and water storage reservoirs.

■ **Corrosion Manual for Internal Corrosion of Water Distribution Systems**  
Item #DWBKDM15—1984

This manual provides information about the causes and types of corrosion, as well as practical guidance for detecting and solving corrosion-related problems.

**NDWC Mission Statement**

The National Drinking Water Clearinghouse assists small communities by collecting, developing, and providing timely information relevant to drinking water issues.

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