MAKING THE MOST OF IT

New and sophisticated treatment technologies were not enough. The team in Murfreesboro learned to optimize performance and cost-effectiveness.

STORY: **JIM FORCE**
PHOTOGRAPHY: **DAN REYNOLDS**

When superintendent Alan Cranford looks out at his upgraded 20 mgd Stones River Water Treatment Plant in Murfreesboro, Tenn., he may be viewing the facility of the future.

Membranes. Granular activated carbon filters. High-tech lime system. On-site sodium hypochlorite generation. Sophisticated SCADA system, including portable data tablets.

But he knows it takes more than state-of-the-art equipment to produce high-quality drinking water for the 100,000 people in his community. Proper training, maintenance, innovation, and resourcefulness on the part of management and staff are just as important.

As contractors installed the new systems in 2007-2010, the Murfreesboro staff took part in a range of training activities, including working closely with manufacturers. And as the new technologies were broken in, Cranford and his team have made improvements and modifications to bring the systems to optimum efficiency and cost-effectiveness.

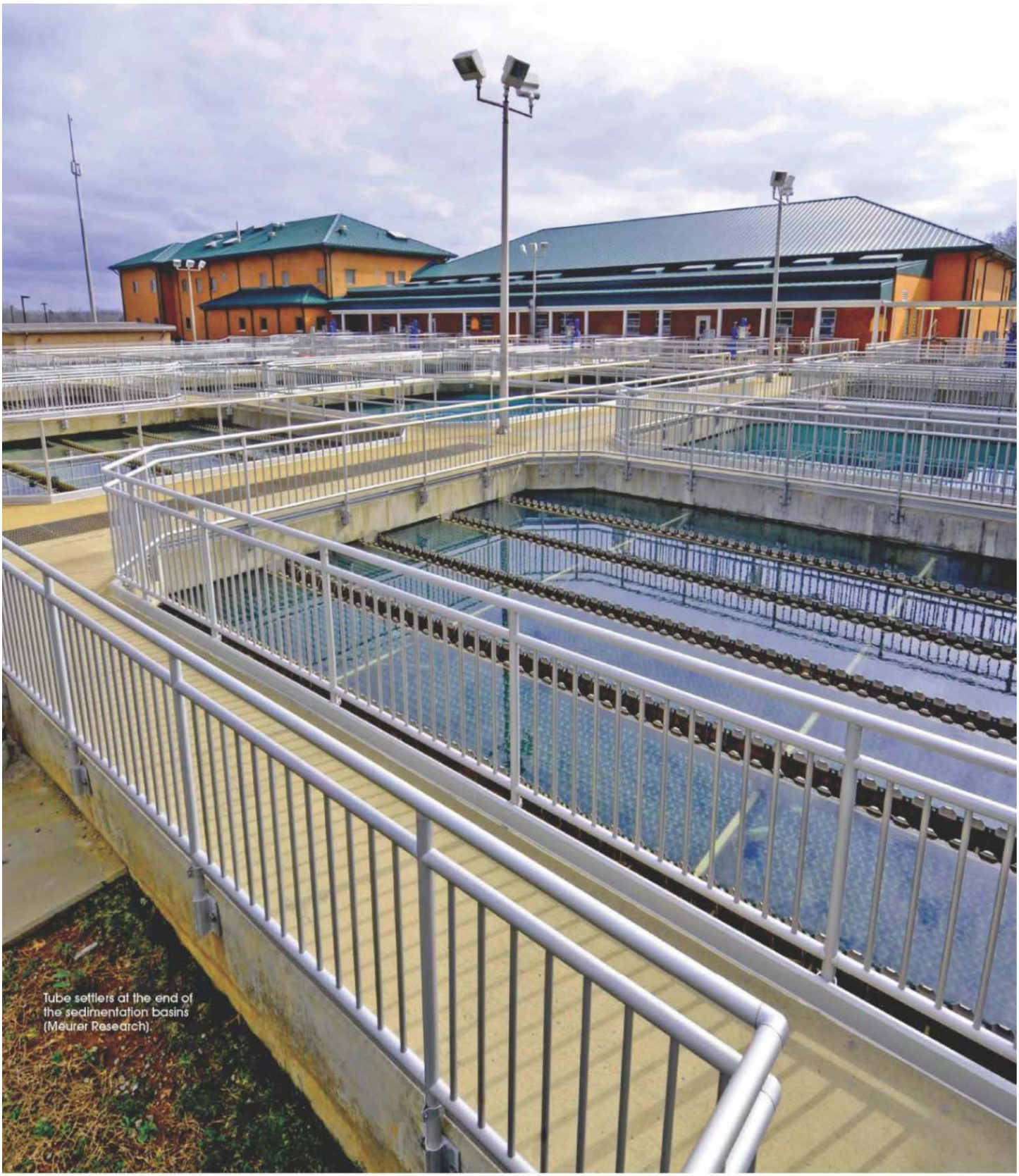
"At this time, our membrane system is the largest in the state, and we remain the only plant in Tennessee using lime softening," says Cranford. "We visited other facilities, required our manufacturers to provide on-site training, and attended conferences and technical sessions to learn about the equipment. And initially, we had our maintenance people work side by side with the manufacturers to develop standard operating procedures and bring the systems up to speed."

> **"We wanted to be proactive and cost-effective in preparing for new EPA regulations covering organics and *Cryptosporidium*. We decided to use membranes as a physical barrier against crypto and *Giardia* and improve the quality of our finished water."**
> ALAN CRANFORD

Cranford leads a team of 30 that includes assistant superintendent Curtis Robertson, administrative support specialist Debbie Crocker, chief lab technician Randy Blurton, chief mechanic Robert Hughes, lead operators Joe Russell, Monte Casto, and Dean West, cross-connection control officer Frank Maccagnano, and IT technician Mike Papula.

Double capacity

The Stones River facility dates to 1967. The original plant had a capacity of 2.0 mgd and was expanded to 15.67 mgd in 1979. It relied on gravity media filters to remove turbidity common to the raw water from the East Fork of the Stones River, especially after heavy rains. Influent turbidity can range from 4 to several hundred NTU. The old plant also used lime softening to combat hardness caused by limestone deposits. Source water can contain 150 to 300 mg/L of total hardness.



Tube settlers at the end of the sedimentation basins (Meurer Research).

The Murfreesboro team includes, from left, lead operator Joe Russell, assistant superintendent Curtis Robertson, superintendent Alan Cranford, cross-connection control officer Frank Maccagnano, lead operator Dean West, chief laboratory technician Randy Blurton, and lead operator Monte Casto.

Stones River Water Treatment Plant, Murfreesboro, Tenn.

BUILT:	1967; upgraded 1979, 2010
POPULATION SERVED:	100,000
SOURCE WATER:	East Fork, Stones River
CAPACITY:	20 mgd design, 10 mgd average
DISTRIBUTION:	432 miles of piping
TREATMENT PROCESS:	Iron and manganese removal, lime softening, membrane and granular activated carbon filtration
SYSTEM STORAGE:	12 million gallons
AWARDS:	Award of Excellence, Kentucky-Tennessee section AWWA
KEY CHALLENGE:	Looking at aeration for disinfection byproducts removal at two sites
ANNUAL BUDGET:	$1.9 million (operations)
WEBSITE:	www.murfreesborotn.gov

Pall Microza microfiltration membranes provide an absolute barrier to pathogens and remove any particles greater than 0.1 micron that are not removed during sedimentation.

A growing population, aging equipment and concerns over future regulations and new contaminants led to the decision to expand again and upgrade treatment. Even with the gravity filters, turbidity had remained an issue. "With the old plant, it was common to have finished water turbidity levels as high as 0.15 NTU," says Cranford.

"Furthermore, we wanted to be proactive and cost-effective in preparing for new EPA regulations covering organics and *Cryptosporidium*. We decided to use membranes as a physical barrier against crypto and *Giardia* and improve the quality of our finished water."

The $40 million plant expansion, designed by Smith Seckman Reid with Building Crafts as general contractor, includes chemical addition for iron and manganese removal, followed by lime softening, sedimentation, membranes and NORIT granular activated carbon (GAC) filters for total organic carbon removal and taste and odor control.

Better disinfection

The membranes consist of ten racks containing Microza LGV 0.1 micron microfiltration modules supplied by Pall Corporation. Designed to maximize recovery and reduce disposal costs, the units have smooth inner and outer membrane skins with a highly porous symmetrical support structure. The system yields high flow rates and offers outside-to-inside flow capabilities, reverse filtration and air scrubbing.

Before the expansion and upgrade, Murfreesboro used chlorine gas disinfection, but the staff felt the old system could become a safety hazard, especially with a Veterans Administration hospital near the plant. That led to selection of a ClorTec on-site sodium hypochlorite system from Severn Trent Services. It includes two 900-pounds-per-day hypochlorite generators, operating concurrently to provide redundancy in case one unit temporarily ceases operation. A pair of 43-ton brine silos and three 15,000-gallon storage tanks complete the package.

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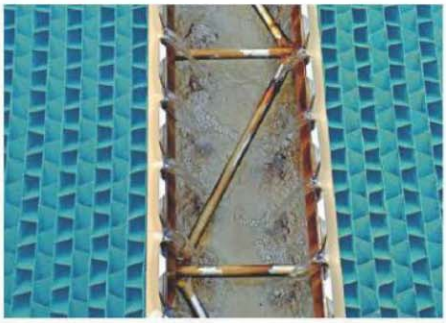
After disinfection, the water is fluoridated before being pumped to users through a 432-mile distribution system. Plant processes are monitored and controlled by a SCADA system supplied by M/R Systems. The controls include handheld tablet PCs, enabling operators to make adjustments from anywhere around the plant.



Tube settlers increase the settling capacity of rectangular sedimentation basins by reducing the vertical distance a floc particle must settle before agglomerating to form larger particles.

Essential training

With so much new technology on the grounds, training of the plant staff was critical. While Murfreesboro followed all the customary training protocols, Cranford feels having the manufacturers train his staff first was a key to success. "We had our staff work side by side with the equipment providers to review the basic operations and maintenance procedures," he reports.

The new membranes were a good example. "Pall's technical service people were excellent," Cranford says. "They were very knowledgeable and gave us good information on how to do things. Our maintenance people worked with them for about three weeks, developing standard operating and maintenance procedures."

As a result, the maintenance staff became intimately familiar with the complete membrane operation, including membrane cleaning, which they performed. "Then we gave hands-on training to our operational staff," Cranford says. "It worked really well."

Murfreesboro also uses a computer-based training program, provided by 360 Water and customized for all pieces of equipment. Operators can access the training modules and take tutorials and review procedures on specific pieces of equipment. Still, old fashioned hands-on methods remain popular. "For me, the best way to learn is hands-on," says lead operator Joe Russell. "It's best when you actually go down there and click the buttons."

Optimizing technology

Plant managers and operators know that once the design consultants and contractors are gone, they have to take ownership and make the new technology work at peak efficiency. Cranford and his staff have taken several steps to optimize the membranes, carbon filters, and lime handling and sodium hypochlorite systems.

"With the membranes, we initially let our maintenance people handle

Senior laboratory technician Alison McGee conducts a total alkalinity test.

all the cleaning processes while the operators controlled the filtration process," says Cranford. "Then we brought the operators up to speed, and they've taken over all the cleaning and operation."

Cranford's team members perform a chemical clean-in-place (CIP) cleaning every 30 days and an enhanced flux maintenance (EFM) cleaning weekly, using sodium hypochlorite.

Performing EFMs and CIPs according to the manufacturer's recommendation is essential to successful membrane operations.

"Operating the membranes is relatively simple, as they operate in automatic mode," explains Cranford. "We get a recovery rate usually between 95 and 97 percent, and the membranes consistently produce water at or below 0.03 NTU." Membrane and GAC filter backwash solids and other treatment plant residuals are pumped to one of two sludge lagoons. Changes in the lagoon operation have improved performance, as well.

"We have open lagoons with one in service at a time," says Cranford. "We've changed coagulants from ferric sulfate to a polyaluminum chlorohydrate (Hyper+Ion 4090 from General Chemical Performance Products). That has reduced our chemical usage dramatically and cut our sludge volume going to the lagoons by 50 percent. Now we anticipate cleaning the lagoons every other year, not every year as in the past." The move has saved more than $70,000 in chemical costs a year and another $15,000 to $17,500 a year in lagoon cleaning costs.

ADVENTURES WITH GAC

For taste and odor control, the Stones River Water Treatment Plant in Murfreesboro uses a series of granular activated carbon (GAC) contactors supplied by NORIT Americas.

The units dealt with taste and odor as designed, and during the first three months of operation, the plant saw a bonus in some removal of disinfection byproducts. Then, as operations continued, DIBP removal essentially disappeared.

"The removal degraded over time," says plant superintendent Alan Cranford. "That's to be expected." Hoping the contactors could return to a state of providing a cost-effective way of removing DIBP, Cranford and his staff chemically cleaned the units in late 2011.

"The cleaning has not improved DIBP removal," Cranford reports. The plant team is working with its engineering consultant to investigate other technologies — such as aeration — for better control of DBPs.

High-tech softening

While Murfreesboro had a history of lime softening, the plant upgrade included a state-of-the-art lime slaking and delivery system from RDP Technologies. "It's a high-tech system, and we worked closely with RDP to get it set up and operational," says Cranford. "It has been outstanding."

Before the expansion, Cranford recalls, Murfreesboro used a gravimetric feed system to make the lime slurry, and that often led to excess lime in the solution tank and considerably more maintenance than with the RDP system.

Programmable logic controllers (PLCs) drive the new system, automatically and precisely regulating the lime recipe and the slaking temperature. "In our case, the recipe is 20 percent lime to water," says Cranford. "The PLC makes batch adjustments in the recipe to make sure we're meeting the quality standard. It's not hit or miss, and we get a more stable pH and better operating costs. If the lime is not as active, the PLC will make an adjustment in the lime-to-water ratio." That's a big improvement over the previous system where lime was augured into the process by gravity and operators used a balance and cup to achieve the desired ratio.

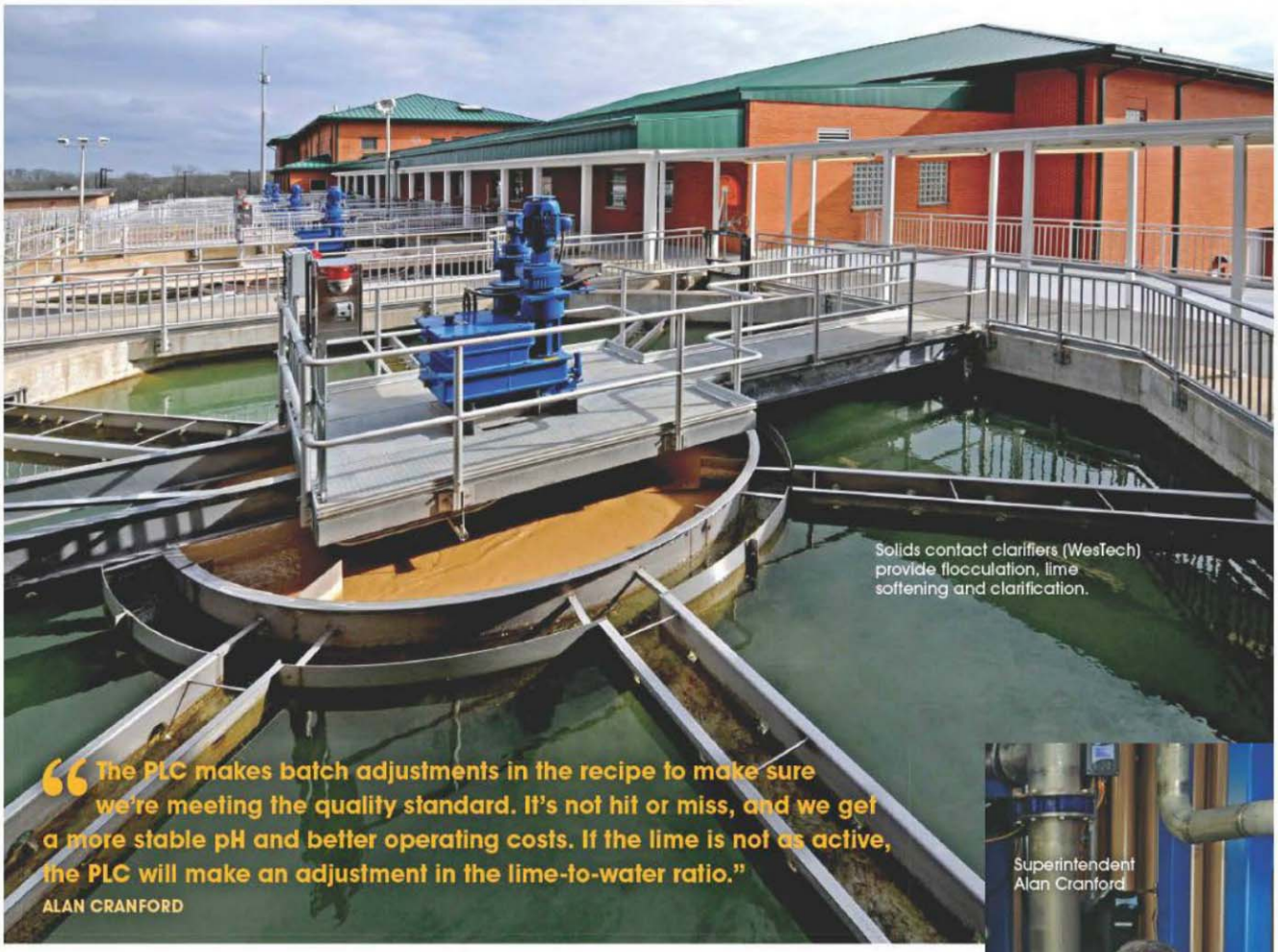
Russell puts it this way: "I never operated the old system, but I know it could result in messes all over the place. This is a great system. There's no comparison in cleanliness and efficiency." The crew had a minor issue with the pinch valves plugging, but by cleaning the valves and the system with a rod before shutdown, they largely eliminated the need to rebuild the pinch valves.

The ClorTec sodium hypochlorite generation process provides good service, as well. It feeds softened water into a brine dissolver to form a brine solution diluted to 0.8 percent. The solution then passes through electrolytic cells, which apply a low-voltage DC current to the brine to produce the sodium hypochlorite solution. From storage tanks, liquid feeders inject the solution into the clearwell to maintain the disinfection requirement.

Workers have had few maintenance issues with the system and follow the manufacturer's cleaning and maintenance recommendations closely. The biggest problem has been the electrodes in the water heaters. "The low hardness may have affected them, but Severn Trent replaced them at no cost to us," Cranford says. A 20-year life cycle evaluation favored on-site generation of sodium hypochlorite over purchasing the chemical in bulk form.

Lessons learned

While the upgraded Murfreesboro plant has been in operation for just two years, Cranford and his staff have already learned valuable lessons.



Solids contact clarifiers (WesTech) provide flocculation, lime softening and clarification.

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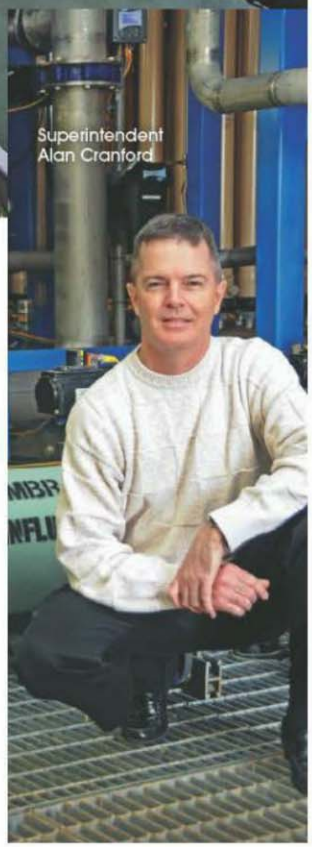

Superintendent Alan Cranford

For one, high-density polyethylene is not a good tank material for sodium hypochlorite. "The material cracks and leaks around the fittings and in the tank bottoms," says Cranford. "We were having hypochlorite leaks within 12 months."

The solution was to convert to fiberglass reinforced plastic (FRP) tanks. "Last May, we switched out all three of our tanks," Cranford says.

Another recommendation involves the automated control systems. "Make sure the manufactured systems and your SCADA system use the same software," Cranford suggests. "Whatever the SCADA software might be, make sure the interface is the same, so your equipment screens are easily incorporated into your SCADA system."

With an increasing number of North America's water treatment facilities undergoing modernization and becoming more automated like Murfreesboro, that's sound advice. **wso**

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