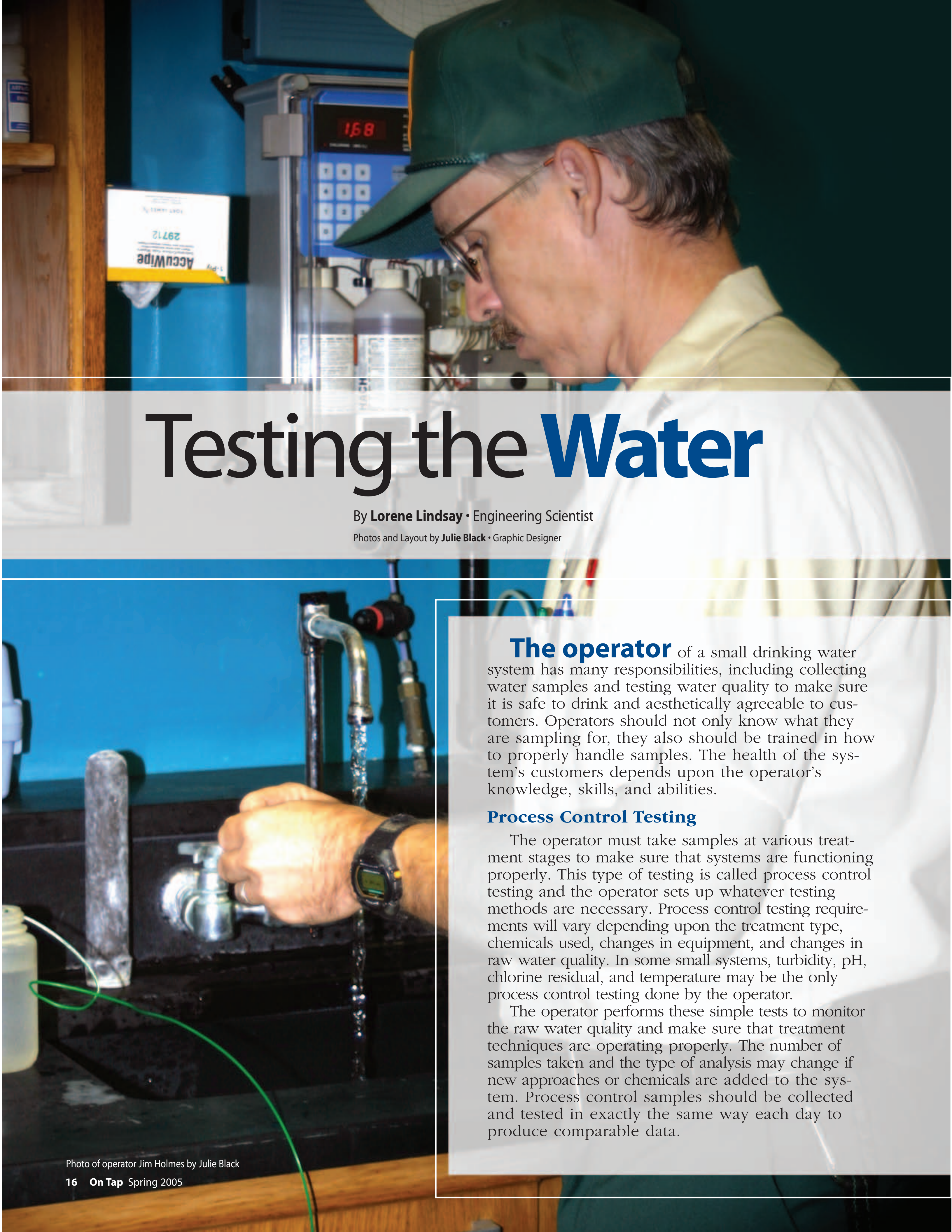

Testing the **Water**

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The operator of a small drinking water system has many responsibilities, including collecting water samples and testing water quality to make sure it is safe to drink and aesthetically agreeable to customers. Operators should not only know what they are sampling for, they also should be trained in how to properly handle samples. The health of the system's customers depends upon the operator's knowledge, skills, and abilities.

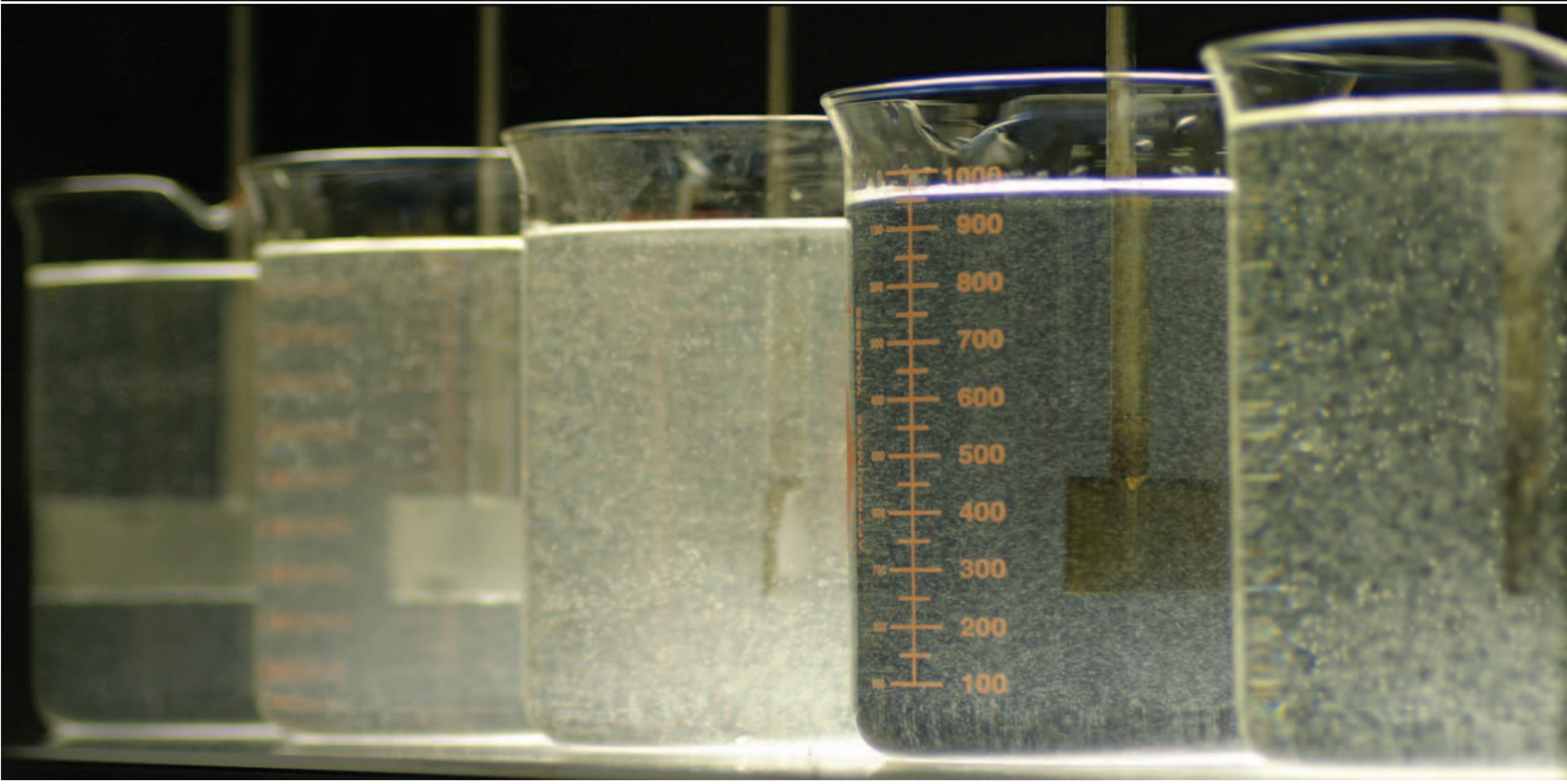
Process Control Testing

The operator must take samples at various treatment stages to make sure that systems are functioning properly. This type of testing is called process control testing and the operator sets up whatever testing methods are necessary. Process control testing requirements will vary depending upon the treatment type, chemicals used, changes in equipment, and changes in raw water quality. In some small systems, turbidity, pH, chlorine residual, and temperature may be the only process control testing done by the operator.

The operator performs these simple tests to monitor the raw water quality and make sure that treatment techniques are operating properly. The number of samples taken and the type of analysis may change if new approaches or chemicals are added to the system. Process control samples should be collected and tested in exactly the same way each day to produce comparable data.

Photo of operator Jim Holmes by Julie Black

Jar testing is the most complex form of process control testing. Jar testing is done to determine the optimum chemical dose, to compare the performance of different chemicals, and to model the coagulation/flocculation/sedimentation processes. (A Tech Brief about jar testing is included in this publication to provide a more complete description of the procedure.)



Process control testing is a valuable tool for the operator and part of the daily routine for running a small drinking water system. Systems that use surface water depend upon process control testing to adjust the treatment method when the raw water quality changes. The operator collects samples throughout the day to monitor treatment and fine-tune the system when needed. Even in groundwater systems, process control tests are used to make sure that good water quality is maintained in the system.

Continuous monitoring devices, such as chlorine residual or turbidity analyzers, are good examples of automatic process control testing. These automatic or in-line analyzers provide continuous data to the operator about how the equipment is operating and the quality of the water produced.

Compliance Testing

Compliance testing refers to the specific required laboratory analyses that must be performed on public drinking water and be reported as required by the Safe Drinking Water Act Amendments. Compliance testing must be performed with strict adherence to requirements in *Standard Methods for the Examination of Water and Wastewater* or using the U.S. Environmental Protection Agency (EPA) *Methods for Chemical Analysis of Water and Wastes*.

The details and methodology described in *Standard Methods* may seem tedious, but they are necessary to ensure that the data is reliable and accurate. The tests must be performed exactly as they are prescribed, and all equipment used must meet the specifications described in *Standard Methods*. For example, a pH meter must be calibrated with at least two buffers and maintain an accuracy of plus or minus 0.1 pH unit.

Quality control and quality assurance testing is also necessary so the lab can prove that analytical data is reliable. *Standard Methods* includes recommended quality control testing for each laboratory analytical method as well as the equipment used in the laboratory. Part 1000 in *Standard Methods* contains a general discussion of statistics and quality control as well as sampling procedures. Also included in this section is a description of laboratory safety, hazardous materials, protective equipment, chemical hygiene, and waste disposal for the laboratory. All of these topics are important if the laboratory is doing compliance testing.

Laboratory Records

Laboratory records from a municipal treatment system must be kept for a minimum of three years, but if a private company runs the plant, then records may be required to be kept for five years. All laboratory records should be filed and easily accessible for inspection by regulatory personnel. Of course, lab records should be kept in ink and in a bound notebook if possible.

When mistakes occur, the correction should be made by drawing one line through the incorrect data, inserting the correct data, and then initialing the correction. Original laboratory bench sheets should be kept and not recopied. It's okay for them to be water stained and messy. Just be sure there are no coffee stains; no food or beverages allowed in the laboratory!

Sampling

Samples for laboratory testing should be representative of the water being tested. That sounds so simple but can be difficult to achieve, especially for samples taken from the distribution system. Drinking water treatment requires samples of raw water, treatment processes, finished water, and water in the distribution system. Samples of raw water must be collected at the well for groundwater supplies or at the intake structure for a surface water supply. Many utilities install a sampling port at the wellhead to allow easy sample collection.

TABLE 1

SAMPLE	CONTAINERS	PRESERVATIVE	(1) MAXIMUM HOLDING TIME
Acidity	Paper, Glass	4° C	24 hours-14 days
Alkalinity	Paper, Glass	4° C	24 h-14 d
Chlorine, Residual	Paper, Glass	None	Analyze immediately
Conductivity	Paper, Glass	4° C	28 d
Fluoride	Paper	None	28 d
Hardness	Paper, Glass	HNO_3 to pH < 2	6 months
Metals, total	Paper, Glass	HNO_3 to pH < 2	6 months
Mercury	Paper, Glass	HNO_3 to pH < 2	28 d
Nitrite	Paper, Glass	4° C	48 h–48 h
Nitrate	Paper, Glass	4° C	None/14 d
Nitrate + Nitrite	Paper, Glass	H_2SO_4 to pH 2 and 4° C	None/14 d
PH	Paper, Glass	None	Analyze immediately
Temperature	Paper, Glass	None	Analyze immediately
Turbidity	Paper, Glass	4° C	24 h–48 h

Source: REI Consultants, Inc.

Collecting samples to monitor the treatment process and the finished water may be grab samples taken at various points in the treatment process, or continuous monitoring devices may collect the data. Continuous monitoring may be required for turbidity and chlorine residual. Continuous monitoring equipment is a great time-saver for the operator but the equipment must be maintained and calibrated precisely.

Collecting samples from the distribution system may be difficult for some small systems. In recent years, the requirements for lead and copper testing have required that samples be taken from all areas of the distribution system, and the sampling plan must be submitted for approval.

The Total Coliform Rule has also complicated sample collection in the distribution system. Under the Total Coliform Rule, if a sample from the distribution system is positive, then repeat samples from the distribution system are required above and below the point where the positive sample occurred. Bacteriological samples must be carefully collected, and the point of collection must meet specific requirements. Installing special sampling taps may be the best way for the utility to provide proper sample locations.

Older distribution systems that experience more leaks and have dead-end lines may require more sampling due to poor water quality. When repairs are made in the distribution system, the lines should be disinfected and sampled for coliform bacteria before returned to service. These samples are termed special samples and the results may or may not be required by the regulatory agency. Remember, for these samples, a fire hydrant or frost-free hydrant is not an acceptable sampling location.

Once an adequate sample location has been selected, the proper sample container must be used. Most water samples are now collected in plastic sample bottles, and the bottle often contains a preservative and should not be rinsed out. For coliform testing the bottle must be sterile and should contain a dechlorination agent such as sodium thiosulfate.

Collecting samples for bacteriological analysis must be carefully done and requires some skill. Most state agencies provide instructions for the collection of samples, and new operators should have hands-on training in sterile technique to properly collect these samples.

Sample preservation, handling, and chain of custody have become extremely important for operators who collect samples and the laboratory technicians that analyze them. The chain of custody is a complete history of the sample from the time of sample collection through the analysis. Each person who handles the sample must be documented in the chain of custody as well as preservation methods. If a complete chain of custody does not accompany a sample, the laboratory will not process it. Most laboratories will include a chain of custody with each sample bottle.

For small utilities that do some of their own testing, the chain of custody may be a simple document; however, when samples are collected and then transported to a private laboratory for analysis, the chain of custody may become quite lengthy.

If the laboratory receives a sample that is older than the prescribed holding time without preservation, it will not be processed. Small utilities often need to ship or transport samples to

The Obsessive Compulsive Detective

Why would Monk be a good lab tech?

Adrian Monk (Tony Shalhoub), the character from the popular USA Network TV program, has an obsessive-compulsive personality. He may spend hours fretting over a particular situation, repeatedly checking its status just to make sure everything is OK. He may even count objects over and again to be sure he was correct the first time. He would make the perfect candidate for laboratory work. He is:

- organized,
- precise,
- detail oriented,
- structured,
- inquisitive,
- absorbed, and
- blessed with total recall.

Photo by Alan Zenuk - © 2002 USA Network

other cities for analysis. The operator must make sure they know the laboratory hours of operation, holiday schedules, and shipping times. Most private laboratories and state-run laboratories do not operate on weekends or holidays. Samples must be shipped so they will arrive at the laboratory with enough time to be processed within the prescribed holding time. Sample preservation and holding times are given in **Table 1**.

For coliform samples that require 24 hours of incubation, the sample must arrive at the lab no later than Thursday so the analysis can be completed before the weekend. Operators must remember to check the holiday schedule and be sure to take required samples early enough in the month to be certain that compliance information will be ready for reporting purposes.

Meters, Probes, and Wet Chemistry

New technology is available everywhere, including the laboratory. Digital meters and automatic recording probes are now available for monitoring common water quality parameters. New requirements for turbidity and chlorine residual testing have made automatic recording probes a necessity for many systems. The automatic probes provide accurate, timely information on water quality, but maintaining and calibrating the probes can take up a lot of the operator's time. The good news is that the technology is improving and becoming more reliable and operator friendly.

Even with all of the new automatic sampling equipment, some of the lab work for even a small drinking water system relies on wet chemistry—a term used for the various laboratory analyses that require adding various chemicals to the sample and measuring the results. Examples of common wet chemistry processes include testing for alkalinity and hardness. These two tests are examples of a lab process called a titration—where the sample is treated with various chemicals including a color indicator to produce a chemical reaction based on the amount of the substance being tested.

When the chemicals are first added to the sample, a particular color will be produced. Then, another chemical (called the titrant) is added very slowly until a color change occurs. The color change occurs when enough titrant is added to react with the original amount of alkalinity in the sample. The amount of titrant used to produce the color change can then be used to calculate the amount of alkalinity in the original sample.

Chemicals used in the laboratory must be of the highest quality and properly stored. The exact composition and concentration of the chemicals must be exactly as prescribed in the methodology. If the quality or concentration is not exactly as specified, then the results of the analysis will not be correct. The chemicals that are used for laboratory testing must be of reagent grade and can be ordered from a number of supply companies. The chemicals will have an expiration date, and old chemicals must be disposed of properly.

In addition, the laboratory chemicals must be properly stored according to the instructions on the Material Safety Data Sheets (MSDS). The MSDS contains reactivity hazards, recommended personal protective equipment for proper use, and first aid in the event of exposure. The MSDS sheets must be kept in the area where the chemical is being used. For the laboratory, this means that a complete set of MSDS sheets must be accessible. Chemicals that are incompatible must be stored in separate areas. Highly flammable chemicals must be stored in approved containers and fireproof cabinets.

Lorene Lindsay has 26 years' experience in water and wastewater treatment and is a certified operator in the state of Missouri.