Quick Response Is Key to Solving Taste-and-Odor Problems

A sudden taste-and-odor incident prompted the city of Westminster, Colo., to seek a faster, more efficient way to detect algae populations before they could affect water quality. BY JONATHAN DAWSON

IN MAY 2007, a rare influx of nutrients into Standley Lake, Westminster, Colo., triggered a surprise algae bloom that quickly affected the taste and odor of the city's drinking water. Thriving on nutrient-rich water, the *Stephanodiscus* algae population soared, then quickly plummeted. However, metabolites generated from the algae's demise sped through the treatment process before testing procedures could detect their presence. Several nearby cities using the same water supply also experienced similar conditions that affected their drinking water quality. The unusual occurrence sounded a wake-up call for Westminster's water quality department.

TIME-CONSUMING PROCEDURE

City staff had been detecting and identifying nuisance algae by counting cells and using an inverted microscope to examine 1-mL settled-water samples. The manual process required as much as several days for a sample to settle before analysis could be performed, and generated data weren't available for months. Traditional microscopes and slides provided great pictures, but someone still had to count and measure the organisms. Along with the potential for missing target algal cells and an inability to efficiently test large samples for minute populations, the delay hindered the city's efforts to find and treat algae before it could bloom and threaten water quality.

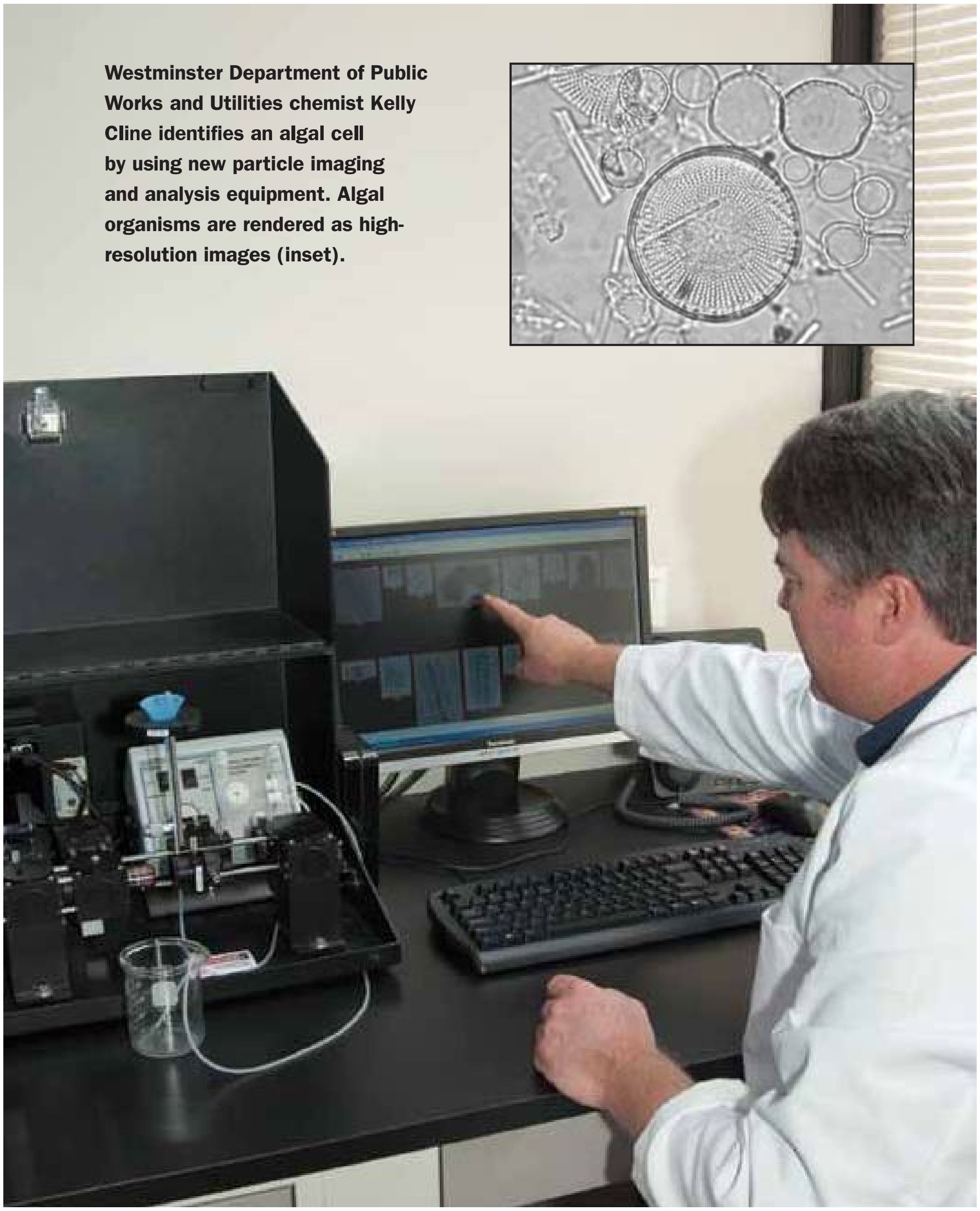
A NEW APPROACH

Determined to prevent future taste-and-odor events, city of Westminster chemist Kelly Cline investigated other ways to detect and identify algal cells. He discovered a particle imaging and analysis system to safeguard drinking water from taste-and-odor events that's being used by several utilities. Combining high-quality microscopy imaging with high-speed flow cytometry, the system automatically takes high-resolution, full-color, digital images of individual particles and microorganisms in a fluid, measures various parameters (size, length, width, shape, equivalent spherical diameter, and fluorescence) in real time, and saves the images and data for analysis. Clicking one of these images on the screen reveals corresponding measurement data, and pattern-recognition software automatically matches detected cells against libraries of known nuisance cells for automated species identification. Each sample often yields 50,000 or more images.

Now Cline can obtain an algae count and report to operators and managers in less than 30 minutes—and be confident the data are accurate. The system's ability to process large sample volumes allows personnel to cost-effectively sample the entire water column from top to bottom. Because algae populations move up and down in the water column, depending on conditions, the top-to-bottom sampling capability ensures nuisance algae are found while the population is still small.

The type and number of particulates found in a sample provide insight into the food of zooplankton, which feed on many autotrophs, heterotrophic organisms, and organic particles. A healthy population of zooplankton and other members of the microbial food web serve as the lake's first line of defense against algae by gobbling up nutrients that would enable a full-fledged bloom to occur. By using the imaging system to track numbers, Cline verified a strong correlation between zooplankton abundance and an increase in particles.

The system can image thousands of particles in seconds without rerunning a sample, which helps users see if an input, such as a nutrient, has occurred and anticipate its potential effect on algae growth.



Westminster Department of Public Works and Utilities chemist Kelly Cline identifies an algal cell by using new particle imaging and analysis equipment. Algal organisms are rendered as high-resolution images (inset).

PHOTOGRAPHS: DANIEL FELDMAN, AWWA; KRISTIAN PETERS (INSET)

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ADDED BONUS

In addition to the challenge of preventing taste-and-odor events caused by algae, the city's treatment team also faced an imminent threat of invasive mussels, which multiply so rapidly they can destroy lake ecology, compromise water treatment infrastructure, and contribute to nuisance algae growth.

In early 2008, zebra mussels were discovered in a Pueblo, Colo., reservoir. By fall of that year, zebra and quagga mussels were confirmed in six other nearby lakes and reservoirs. The Westminster water quality team swiftly established a program and partnered with the state of Colorado to conduct microscopic water testing and analysis to detect mussel presence in Standley Lake. Ideally, mussels should be detected at the larval veliger stage before they can become entrenched.

Initial testing was limited by the inability to test large amounts of water and the time required for manual microscopy. The process was slow, and there weren't enough people using proper techniques to detect the veligers. Genetic analysis was also considered, but it wasn't a viable option because of its relatively high cost and slow turnaround time.

But there was good news. In addition to serving as an early-warning system for taste-and-odor algae, the imaging and analysis system is equally effective for detecting, counting, and identifying zooplankton, invasive mussel veligers, and various particulates in a single water sample processed at the same time.

The system offers cross-polarizing filters that reveal particles and microorganisms that exhibit birefringence, such as sugars, starches, fibers, and mussel veligers. Capable of managing large volumes of water, the system automatically detects zebra, quagga, and other aquatic mussel veligers in minutes and images individual veligers for 100 percent confirmation of their presence.

Fortunately, city personnel haven't detected mussels in Standley Lake, but the imaging system is providing assurances and advancing the city's plan of prevention.

HOLISTIC APPROACH

Taking a holistic approach to maintaining the health of the water system, Cline and his team focus on managing water quality naturally without relying on chemical treatments, except when potassium permanganate or carbon must be used. Common in-lake treatment methods, such as copper sulfate, affect every type of algae, including those that pose no threat to water quality. However, there's no way to predict what will grow in the aftermath.

If the presence of nuisance algae can be documented early and the reason for their presence determined, water quality personnel can avoid needing chemicals, according to Cline. The imaging and analysis system provides a complete view of how the entire system is working at all times, putting treatment personnel in a better position to reduce algae growth and, if needed, to remediate with less impact.

The Westminster water quality department hasn't experienced an algae bloom or an invasion of mussels since purchasing the imaging and analysis system. In addition, the technology is being used to aid neighboring cities. Cline uses the system to run samples for his colleagues and has helped them detect and track significant algae blooms. By detecting and tracking *Anabaena*, for example, the system helped a neighboring water quality team recognize an impending bloom, allowing the team to take appropriate remedial action with more than a month's notice.