| January/February 2019 |

TEXAS h2o

The Official Newsletter of the Texas Section AWWA | Every Drop, Every Day, Everywhere©

FEATURES

ALSO IN THIS ISSUE

Legislative Lunch Breaks Info | Calendar | And More!

Using an Integrated Approach to Monitor Algal Blooms

One drinking water utility found a comprehensive, cost-effective strategy for monitoring toxin-producing cyanobacteria that can harm water quality.

BY HUNTER ADAMS, SAM REEDER & MARK SOUTHARD, city of wichita falls
FRANCES BUERKENS, fluid imaging technologies
ASHLEY COTTRELL, texas state university

Most drinking water utilities enter high-alert mode upon testing positive for microcystin. Staff at the City of Wichita Falls Water Purification Laboratory responded calmly when they received that dreaded phone call in July 2018 because of their progressive approach to monitoring cyanobacteria.

In Texas, climate conditions are conducive to harmful algae blooms (HABs) as well as taste-and-odor events with increasing frequency and intensity. Warm summers and mild winters allow cyanobacteria to thrive in this region. On a national scale, US Environmental Protection Agency (USEPA) regulations are moving toward requiring cyanobacteria monitoring. Proactive drinking water utilities are seeking a streamlined approach to monitoring cyanobacteria and nuisance algae.

CONTINUED PAGE 18 | algal blooms

CONTINUED FROM PAGE 10 | algal blooms

Investigate Before Taking Action

No single method answers all the fundamental questions needed to make cyanobacteria treatment decisions and ensure a safe water supply. Those questions include the following:

1. Are cyanobacteria present in the reservoir?
2. What quantity of cyanobacteria are present?
3. Can the species produce toxins?
4. What is the concentration of cyanotoxins?
5. How do we know if we have a problem?

The City of Wichita Falls poses these key questions to identify nascent problems. When a cyanobacteria spike occurs, it is important to treat a reservoir while contamination levels are at barely detectable limits to diminish large-scale *Microcystis* outbreaks and cyanotoxin issues.

An Integrated Monitoring Approach

The city incorporated FlowCam, a flow imaging microscope from Fluid Imaging Technologies, with three other methods—quantitative polymerase chain reaction (qPCR) with the CyanoDTec from Phytoxigene, liquid chromatography–tandem mass spectrometry (LC-MS/MS) outsourced to a private laboratory, and gas chromatography–mass spectrometry (GC/MS) from Thermo Fisher Scientific—in an integrated strategy to monitor two lakes and one holding reservoir. The methods build on one another. Some are used multiple times each week for triage, whereas other methods, such as LC-MS/MS, are used only on an as-needed basis because of the high cost per sample.

Flow Imaging Microscopy. The city uses a FlowCam—a semi-automated microscope—to run samples three times each week in the summer and once each week in the winter. The instrument is used to identify and enumerate filter-clogging algae, taste-and-odor algae, and cyanobacteria. Besides an initial capital investment, there is no cost per sample and no limit to the number of samples that can be analyzed. The flow imaging microscope works quickly; it used to take the city three to four hours to do algae counts in the summer, but now

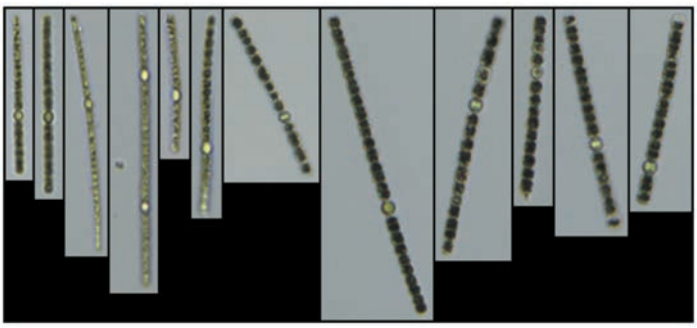

Fig 1: Anabaena images captured by FlowCam during the algae bloom in June (Fig 2)

it takes 15 minutes.

Elevated counts for filter-clogging diatoms or taste-and-odor producers are used to trigger immediate treatment. *Anabaena* concentrations of 100–200 chains/mL indicate an oncoming taste-and-odor event. *Microcystis* concentrations of 500 colonies/mL trigger immediate qPCR tests. Due to the size of Texas, every region is different, so other utilities may find different counts have different effects. It is not a one-size-fits-all situation, especially with water quality variation and limited USEPA guidance.

qPCR. The city uses qPCR once each week to confirm if cyanobacteria in samples have toxin-producing genes. Having *Microcystis* in a sample does not mean the source water will have the neurotoxin microcystin. If the toxin-producing genes are not present or activated, then microcystin will not be present. In fact, Wichita Falls sees *Microcystis*, *Anabaena*, and *Oscillatoria* in its reservoirs, and all three can produce microcystin. A flow imaging sample in July yielded 400 chains/mL of *Oscillatoria*, justifying an immediate qPCR test. The qPCR test that followed showed that microcystin-producing genes were present. The qPCR test costs $50 per sample and takes 40–60 minutes to yield results.

PCR is a positive/negative test, whereas qPCR is quantitative. The qPCR test establishes a calibration curve to quantify results. The qPCR results in July 2018 showed a detection with the PCR curve, but the cycle time was later than the lowest calibration standard. This showed that microcystin-producing genes were

CONTINUED PAGE 20 | algal blooms

CONTINUED FROM PAGE 19 | algal blooms

present at >20 copies/µL, but at a rate lower than their lowest calibration level. Despite the low levels, city staff played it safe and confirmed toxicity levels with an LC-MS/MS test.

LC-MS/MS. If the qPCR results are positive for the presence of toxin-producing genes, it is time to do a toxin test. For example, one city sample tested positive using an LC-MS/MS toxin test for microcystin. The toxin's concentration in lake and tap water samples was below the lowest calibration standard, tagging 0.015 µg/L.

LC-MS/MS analysis is currently conducted by a third party for Wichita Falls, with a standard turnaround time of two weeks (or five days at double the price). Microcystin and nodularin are analyzed by USEPA 544, and cylindrospermopsin and anatoxin are analyzed by USEPA 545. The battery of toxin tests for three samples (raw surface water and two plant samples) costs around $900.

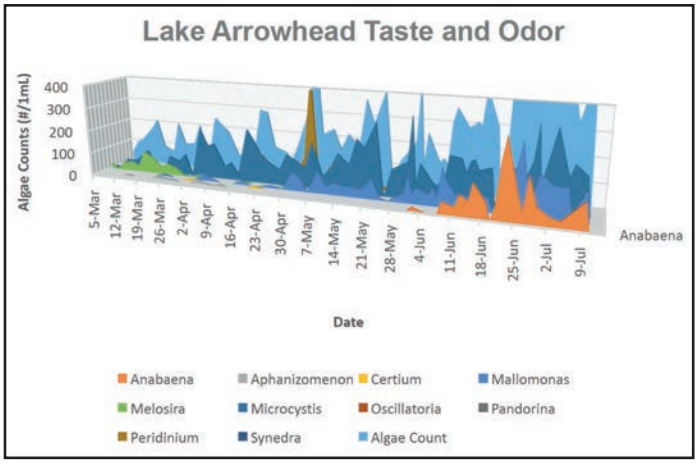

Fig 2: Algae counts measured by FlowCam saw elevated levels of *Anabaena* in June. A spike in *Anabaena* is used as a predictive indicator of an impending taste and odor event, as it often correlates with a spike in geosmin (Fig 3)

Only two events to date have warranted a toxin test, a record that has made it cost-effective to outsource sample analysis. FlowCam data and qPCR test results are used to justify doing or skipping a toxin test. More than one type of toxin test is available, and the enzyme-linked immunosorbent assay (ELISA), a well-known method, is a lot cheaper than LC-MS/MS.

However, ELISA results are not always reliable. When it comes to public safety, reliability is critical. Thus, the city's team uses mass spectrometry, as LC-MS/MS results are reliable.

GC-MS. GC-MS analyses are also part of the toolkit the city of Wichita Falls uses to monitor taste-and-odor taxa. These analyses run three days each week to monitor 2-methylisoborneol (MIB) and geosmin, which are common taste-and-odor compounds in drinking water. A flow imaging count exceeding 200 chains/mL for *Anabaena* may indicate a taste-and-odor event

is on the horizon because geosmin has been seen to increase with high *Anabaena* counts.

Wichita Falls treats its water with powdered activated carbon (PAC) to remove geosmin and MIB. Treatment with PAC is initiated when GC-MS results confirm the taste-and-odor compounds are present. Outsourcing sample analysis costs around $200/sample for MIB/geosmin. The fastest turnaround time for sample results is one hour per sample. In a normal run, results for the entire sample set are available by the beginning of the next workday.

This strategy has prevented larger outbreaks, compared to the previous years, and has all but eliminated taste and odor customer complaints. It has been 849 days since Wichita Falls' last taste and odor outbreak. In that time, there have been five taste and odor events that warranted increased treatment with PAC. Promoting these numbers helps the city and customers appreciate what their water provider is doing for them.

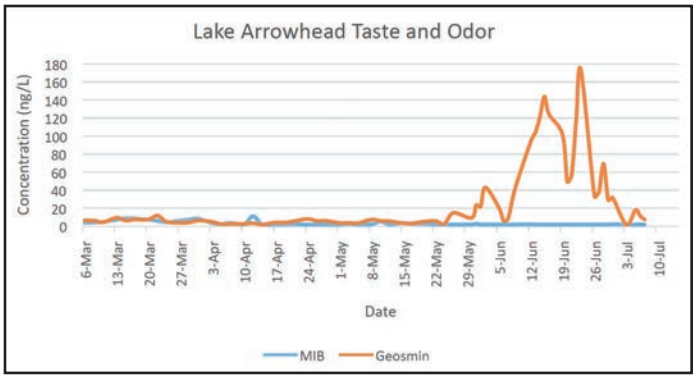

Fig 3: GC-MS test results confirm elevated levels of geosmin in June, which correlates with the spike in Anabaena (Fig 2)

Getting the Job Done

In Texas, Wichita Falls faces formidable ecological conditions that are conducive to significant cyanobacteria blooms and taste-and-odor events. The city's water quality team has put the best technologies to work to keep its water clean and clear and its consumers happy. Using an imaging particle analyzer is part of an integrated, economical approach that incorporates many data points and several testing strategies while using an intelligent combination of resources.

As this municipal example shows, no single test will provide all the answers. A comprehensive analysis is necessary. This strategy has reduced outbreak size compared with previous years and has all but eliminated taste-and-odor customer complaints. It's been nearly two years since Wichita Falls' last taste-and-odor outbreak. Increasing that number is one of the city's primary water quality goals.