Managing the Demand for Clean, Safe Water in the Middle of Nutrient-Laden Farmland

At one million strong and growing, the population of a Midwestern U.S. city has a high demand for potable water. But in the local waterways lurk compounds that pose a threat to these citizens' drinking water.

The office gets tense when the manager and supervisors of the city's water division-water lab field anxious phone calls each time a water quality alert is issued. If something interrupts the supply of tap water, citizens are likely to speak out about it. After patiently talking to customers, the lab personnel return to a set of computer monitors, where they are keeping a close eye on real-time water quality data in search of links between water quality conditions at the source and drinking water quality out of the tap.

Primarily they are concerned with compounds from agricultural runoff. Fertilizer and herbicide runoff from surrounding farmland (heavily planted with corn) make their way into the rivers and on-stream reservoirs that the city has used for many decades. When the city's administration contacts the water lab – during an alert period or any time in between – the lab management is ready with up-to-the-minute reports on the quality of their source water in two major rivers and the reservoirs these feed.

A YSI Vertical Profiling System (above) and 6600 sonde (below) are deployed in on-stream reservoirs in order to collect real-time source water data

Nitrate is the stickler

The water lab wants to know more about the source water's quality before they treat it. According to one of the lab supervisors, with the continuous monitoring systems they now use outside the plants (that draw directly from the impoundments and reservoirs), they have been able to track rapid increases in nitrate that they otherwise would have missed with the sampling programs used in the past.

They have seen some nitrate events which quickly spike up to levels as high as 15 mg/L, but do not last long. Even still, since the treatment plants do not currently have the capability to treat nitrate, the lab has to issue warnings to the public if the plants release this water into the distribution system. And that's when the phone calls begin.

YSI 9600 Nitrate Analyzers are a key component in the city's continuous monitoring system. One of the managers notes that the *in situ* analyzers give them a constant supply of data, providing accurate measurements of nitrate concentrations every hour.

Multiple benefits to continuous monitoring

Besides nitrate, there are other parameters of concern for which they can successfully act. The lab has researched and deployed additional technology which not only provides real-time data but also helps them adjust their reservoir withdrawal (or release) elevation and treatment methods at the plant. The continuous monitoring systems in use have had additional benefits as well.

For example, in the hot summer months an invisible, undesirable substance collects in the water body. This is another byproduct of farming – atrazine, a herbicide. Atrazine runs off into the rivers and reservoirs and forms a layer above the thermocline. The hot weather also leads to algal blooms and low oxygen conditions.

So, in the city's largest reservoir, which produces 100 million gallons of potable water per day, the water division employs a YSI Vertical Profiling System. The profiler coupled with a multiparameter water quality sonde allows the team to continuously monitor stratification, thermocline depth, pH, conductivity, algal biomass and dissolved oxygen levels throughout the water column. The system is situated near the dam, which has three release gates staged at various depths. The YSI profiler – a floating platform and mechanical winch – lowers the YSI sonde into the water column and then raises it, taking readings at user-defined intervals.

The managers have come to realize that the cleaner the water is before it enters the plant, the easier and less expensive it is to treat it before customers turn on their taps. Therefore these data are extremely useful in choosing appropriate water release points and predicting potential water quality degradation.

The lab has programmed the profiler to run four to six times each day. From the data collected, the managers can analyze

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the thermocline near the dam, identifying that optimal layer, and then inform the plant which release to open. They track the data on an internal website (which the plant managers also have access to), eliminating the need to travel to the reservoir and take samples.

While data from continuous monitoring has been a labor-saving boon, there are still occasions when sampling is helpful. When the managers observe an increase in chlorophyll levels – delivered to their website via YSI sondes deployed directly in the rivers and reservoirs – then they schedule a site visit to gather more information. The YSI systems are used as a trigger to initiate more expensive yet specific laboratory analysis – such as cell identification and toxin analysis.

Reducing costs while dealing with algae

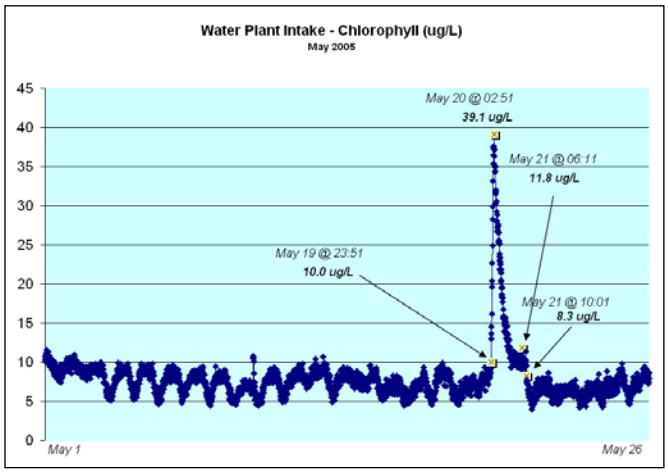
Chlorophyll and blue-green algae sensors on the YSI sonde are effective at monitoring algal biomass continuously and can provide a means of tracking when an algae population is on the rise, potentially leading to a nuisance bloom (most likely the result of that agricultural runoff again). Since the species of algae vary and respond differently to treatment, the lab will go out to the river and collect samples for cell identification.

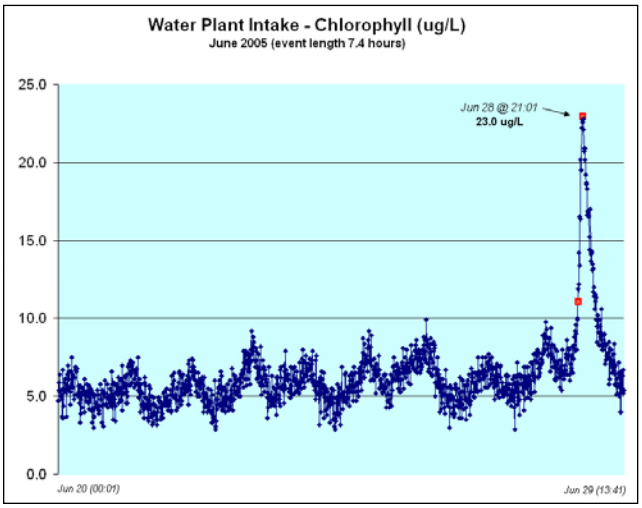
They could find just about anything in those samples. They may be relieved to discover that the particular algae are non-threatening. Or it might be a nuisance species such as diatoms that can clog their filters. It might be a toxic variety that is going to require chemicals to remove it from the water supply. Or it might lead to a taste-and-odor occurrence that is going to stir up those phone calls again.

Dealing with algae can be costly. Often lab managers and plant operators will introduce potassium permanganate (KOH) or powdered activated carbon (PAC) to the treatment process. This can be a necessary but expensive decision, costing $6,000 to $10,000 per day. As the lab manager recalls, before continuous monitoring, they could have used these chemicals for days between sampling periods. Now the real-time chlorophyll and blue-green algae data help them treat more precisely, only while the algae levels are elevated. Using PAC only when they need it – not any longer – reduces their costs.

The more data they have, the better it helps them to make decisions and manage processes daily, agree the lab management. As their city's population continues to grow, the water division is planning to expand its network by building several new reservoirs even further upstream. The lab is looking forward to adding more YSI monitoring instruments to their environmental network in order to keep an eye on the more remote corners of the watershed.

Additionally, the security of the water supply is a key concern. Possible sources of contamination include major highways crossing the rivers and a jet fuel pipeline nearby. As they develop a master security plan for its residents, city leaders will tap into





Data from continuous monitoring captured two events where chlorophyll levels in the rivers rose quickly over several hours or days.

the wealth of data already collected by the lab. The lab predicts that one of its soon-to-arrive challenges will be how to combine data from many sources and make it useful to water treatment plants and the public.

Chemicals from agricultural runoff continue to pose a threat. The lab shares data with a watershed partnership comprised of government researchers and scientists, farmers, and water utility representatives. Together they are examining new ways in which to preserve the region's water assets. This collaboration "upstream" to mitigate pollution is a welcome development for the water lab. The better they and others can control the source water, the easier it is for them to realize their end goal: to deliver a better and more secure product to their customers. And better water means a calmer day in the lab – a day with satisfied customers and fewer phone calls from concerned citizens.

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