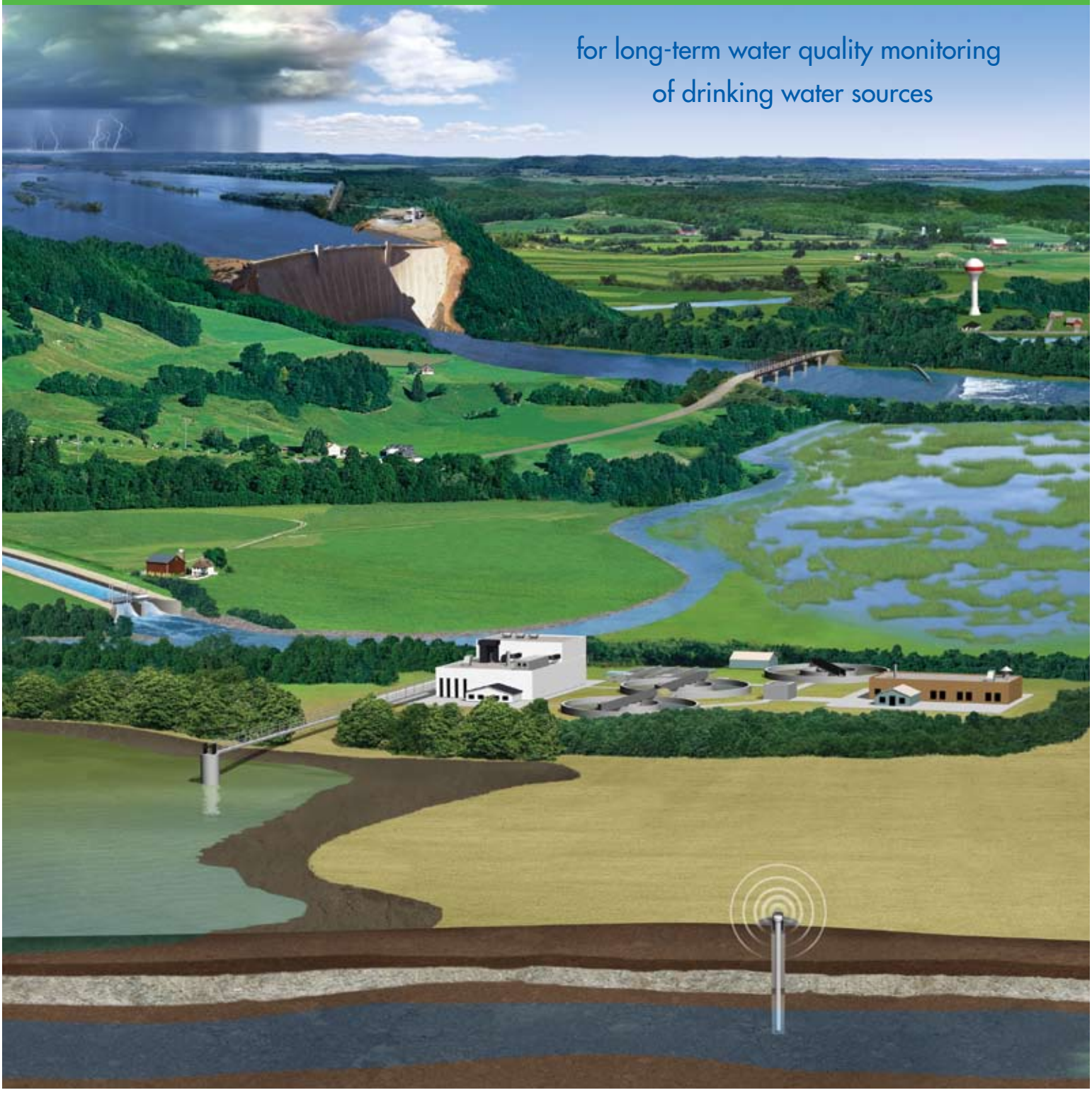
YSI

monitoring

source water

Case Studies & Solutions

for long-term water quality monitoring
of drinking water sources



Baseline Monitoring and Early Warning for Source Water

Continuous monitoring provides timely data to help you address water quality issues before they escalate

Protecting the sources of drinking water is a key concern among water professionals. We rely on water for our most basic needs. As we have observed since the beginning of the industrial revolution, there are many threats to the quality of this water.

Global climate change is affecting ecosystems—some areas experience drought, some flooding, some experience both in devastating cycles—and the protection and efficient usage of source water becomes even more important.

Developing alongside this source water quality concern have been newer technologies that will help to address the issues. One way is through **continuous monitoring** which provides crucial data about the health of source water (measured through water quality parameters such as *temperature, dissolved oxygen, salinity, pH, turbidity, chlorophyll, and others*). Increasingly these systems can provide more highly resolved data at a near real-time pace. Monitoring stations located throughout a source water network—typically rivers, lakes, and reservoirs—produce an excellent, comprehensive view and help to identify particular areas of concern.

Issues may include algal blooms that can lead to taste and odor concerns or high concentrations of trihalomethanes; temperature stratification; point source pollution; low dissolved oxygen levels that allow the release of phosphorus, iron, or manganese; or high turbidity that may clog filters.

Accurate, **real-time data collection and analysis** gives managers insight into their water supplies and gives them the information they need to act quickly to address issues—inside or outside the plant. This knowledge provides assurances of safety. And it can help operators optimize their resource management and treatment processes for increased efficiency.

YSI is proud to be a part of this process. No other company has the long-term monitoring features and experience that we offer. Our simple goal is to provide the most reliable water quality monitoring systems requiring the least frequent maintenance possible. This, combined with our dedicated and knowledgeable technical support, **lowers the cost of ownership** for our customers and thus increases the number of monitoring systems deployed worldwide.

With reliable data from YSI instruments, monitoring groups are able to continue the critical work of protecting our most important natural resource, water.

Happy Monitoring from your partners on the YSI Environmental Monitoring Team.

Source Water Monitoring

The case studies in this report are organized as follows:

1-4	Rivers/Tributaries
5-9	Lakes/Reservoirs
10-11	Water Treatment Plants

Customer Class Environmental Consultant for Federal Monitoring Agency
Environment Remote Freshwater Watershed
Location Czech Republic

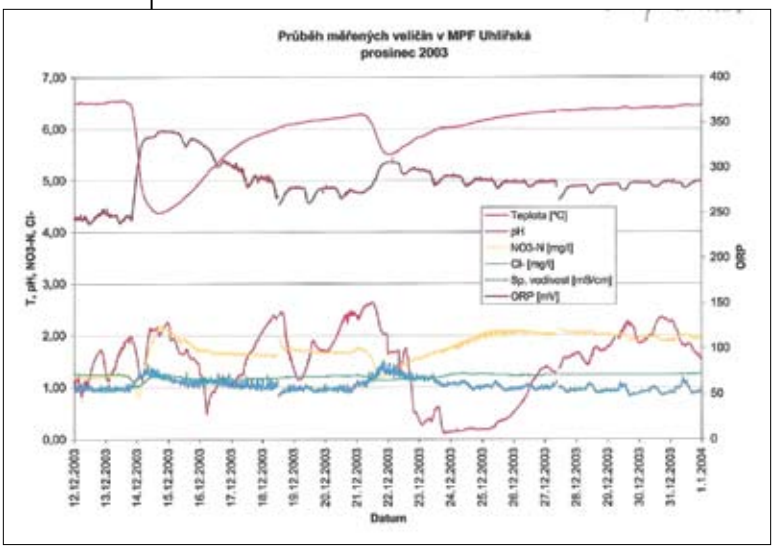
Acid rain affects a remote watershed in the mountains—an important drinking water supply

Situation: A federal authority hired a water quality consultant to collect data in a remote watershed in the mountains. The watershed provides one-fifth of the country's drinking water and is susceptible to acid rain created by sulphur dioxide emissions from nearby power generation plants. The watershed quality is also exacerbated by erosion and forest degradation in the mountains.

Technology: The consultant chose to use three YSI multiparameter sondes to collect the data because of the sondes' reliability, data handling capability, and accuracy. The parameters for measurement include temperature, conductivity, pH, oxidation reduction potential (ORP), chloride, nitrate, and depth. Two sondes are installed at gauging stations within tributaries that feed a catchment and a third sonde is installed at the source of one of the tributaries.

Continuous monitoring reveals large fluctuations in pH levels relative to rainfall and air pollution

Data: Prior to continuous monitoring, weekly (or less frequent) sampling for laboratory analysis was problematic. The site is remote and visits are costly. Continuous monitoring has revealed diurnal and seasonal trends—such as reductions in pH from 6.5 to 4.4 or 6.2 to 5.5 during snow melts—that the periodic sampling program missed. During these periods of higher volume, the water mixes with acidic soil and this low-pH water is delivered to the catchment. The data helps the government link the water quality in their upper watershed to acid rain and gives them political leverage when seeking to mitigate the effects of air pollution coming from surrounding countries.



"Dollars & Sense": In remote locations, unattended monitoring reduces the cost of personnel and equipment going to the field for sampling, while at the same time provides continuous, up-to-date data. Because the sondes are designed specifically for long-term deployments in a variety of conditions, they do not require extra maintenance or calibration from the consultant. For the customer, the benefits of purchasing data, rather than instruments, are: 1) unnecessary equipment does not remain at end of project and 2) savings in labor costs because the user does not have to employ technical staff to install, operate, and maintain equipment.

See YSI Application Note A528 for more details

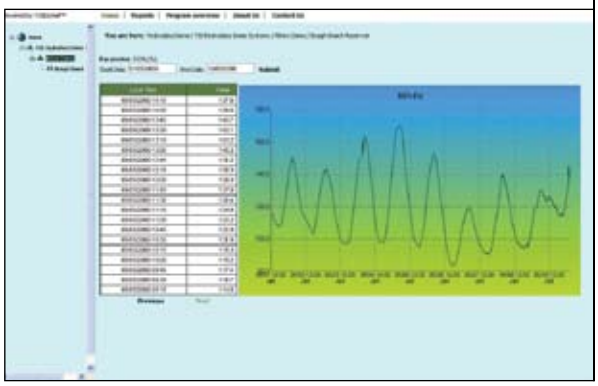
Customer Class Environmental Consultant for Private Water Utility
Environment River
Location United Kingdom

River monitoring reveals diurnal fluctuations and sends alerts for values that exceed set limits

Situation: A private water utility contracted a large engineering consultant to provide monitoring services for its source water in rivers and storage reservoirs. The utility has received special permits to extract water from local rivers in order to replenish the reservoir during a serious drought. However, it has to make certain that the extraction does not impact the rivers too severely, wherein dissolved oxygen levels cannot fall below 50% saturation.

Technology: The consultant used a YSI multiparameter sonde because it provides reliable long-term data. The sonde is deployed in the river via a simple chain and post on the river bank. The parameters for measurement include temperature, conductivity, pH, and dissolved oxygen. The sonde initially was connected to a YSI EcoNet telemetry system, which transmitted data via GPRS to the consultant's web-based server. Authorized users were able to access data from anywhere with Internet connectivity. A later modification, at the utility's request, connects the sonde via cable to a YSI 6500 Monitoring System, which provides scalable 4-20 mA outputs directly to the utility's SCADA.

Data: Close monitoring of water quality data from a remote office (either the consultant's or the agency's) allows the managers to keep tabs on the impact on the river when refilling the reservoir. Coinciding flow measurements let them know when the river begins to drop below acceptable levels, forcing them to stop. At the same time, DO data helps them stay in compliance with federal guidelines—the quality of the water downstream from the intake cannot be adversely impacted by a large withdrawal.



"Dollars & Sense": Remote monitoring of the site allows the utility to collect and view the latest data at any time, providing precise information during drought and reducing the cost of site visits for sampling. This is an economical and informative system for the water utility to use for compliance purposes. Following the period of drought, the utility continues to use the system to check DO data downstream whenever it extracts water from the river.

See YSI Application Note A547 for more details

Customer Class Environmental Consultant for Federal Monitoring Agency
Environment Rivers
Location Malaysia

Safeguarding a water supply is achievable with the early warning benefits of unattended river monitoring systems

Situation: Working with a consulting company, the country's Department of the Environment (DOE) gathers long-term trend data on water quality while also maintaining an early warning system to alert officials and water treatment operators of pollution discharges in key reaches of their river system. Drinking water for 24 million residents is provided mainly by this surface water source.

Technology: The country has thousands of manual sampling sites as well as 15 unattended monitoring stations at critical locations. Nine of the continuous water quality monitoring stations, each equipped with YSI 6600 multiparameter sondes, are installed upstream of drinking water treatment plant intakes. Three more sit downstream of key industrial areas, and three stations are sited downstream of urban areas. Every 15 minutes, each YSI sonde measures temperature, conductivity, dissolved oxygen and ammonia. A YSI 6200 Data Acquisition System interfaces with the sondes and transmits the data via GSM to the consultant and the DOE.

Data: Data from the stations—as well as the manually sampled sites—is formatted in YSI's EcoWatch DCP software, which automates collection and data management. Conductivity is a strong indicator of contamination from metals discharged by industrial polluters. Ammonia levels help regulators stay abreast of sewage discharges, and dissolved oxygen helps monitor output from food processing plants along the rivers, among other pollutant sources. If over-limit values are detected, EcoWatch flags the data and automatically triggers the early warning system. Emergency alerts lead to a quick closing of intakes at water treatment plants downstream of the stations, and can trigger enforcement actions upstream (for discharges that exceed maximum levels).

"Dollars & Sense": The consultant chose YSI equipment because it is a good value—long-term, accurate performance means a lower cost of ownership over the lifetime of the product. Each monitoring station is designed to last for the duration of the 20-year contract. Also, technicians for the monitoring sites find the sondes easy to calibrate and install, making their twice-monthly field visits a trouble-free experience. Finally, the YSI equipment interfaces with other data systems, all of which inform an Integrated River Basin Management system for the future of the country's water supply.

See YSI Application Note A559 for more details

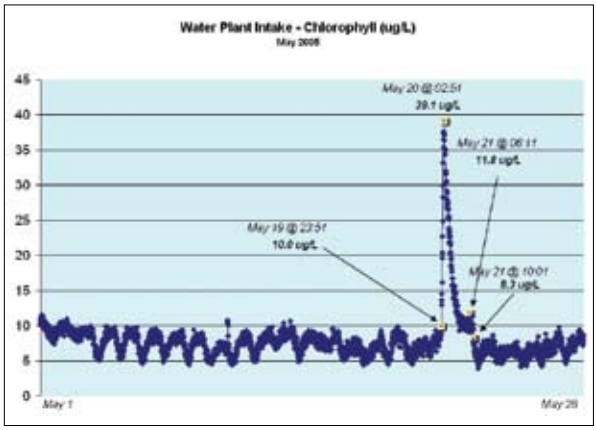
Customer Class Municipal Monitoring Agency
Environment Rivers
Location Midwestern City, USA

Situation: A municipal water quality laboratory is responsible for delivering consistently high quality drinking water to a city with a growing population. Its water division draws water from three main sources, including two rivers with several open reservoirs. Throughout the large watershed agricultural runoff and heavy rainfall push chemicals into the water, affecting the quality of the raw water drawn into its three treatment plants.

Technology: The lab identified a new technology that enabled them to switch from weekly or monthly sampling to continuous monitoring. They use several YSI multiparameter sondes and nitrate analyzers deployed directly in the rivers and a YSI Vertical Profiling System in a reservoir. Parameters of concern include chlorophyll, nitrate, pH, blue-green algae, and dissolved oxygen. Data is sent via telemetry to the lab every hour.

Data: Prior to continuous monitoring, sampling did not provide timely data on emerging events, such as spikes of nitrate concentrations up to 15 mg/L in a matter of hours. Additionally, the Profiler data helps them monitor stratification in the reservoir and determine which layer is best for releasing into the plant, enabling them to avoid high algae and atrazine (herbicide) levels above and hypoxic (low oxygen) conditions below the thermocline.

"Dollars & Sense": In conjunction with operations managers, the lab uses real-time data to respond quickly to water quality fluctuations and adjust treatment processes accordingly. When chlorophyll data indicates a rise in algae biomass, the treatment plants are able to change filtration strategies or add chemicals to avoid taste-and-odor events and reduce the particle load. Since powdered activated carbon costs between $6,000-10,000/day, real-time data lets the managers know when to start and stop using the chemical without overtreating the water and thus saving money.



Top: Data from continuous monitoring reveals chlorophyll levels rising quickly over several hours. This correlated with a taste-and-odor event. Above: A YSI sonde is easily deployed in an on-stream reservoir in order to collect the real-time data.

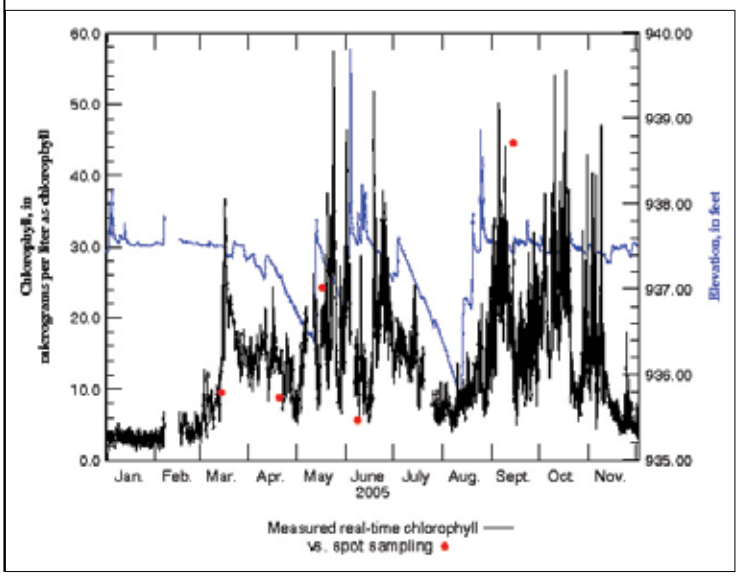
See YSI Application Note A560 for more details

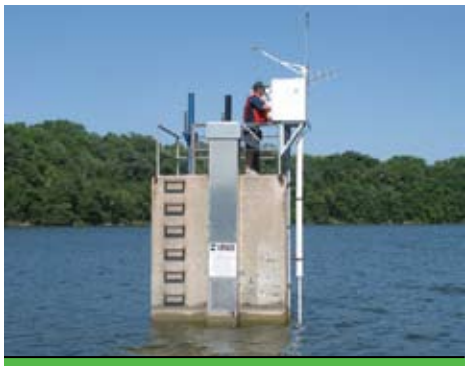
Customer Class Municipal Monitoring Agency
Environment Lake and Reservoir
Location Midwestern City, USA

Continuous monitoring is necessary in order to obtain an accurate record of the rapid changes in water quality conditions in natural environments

Situation: A municipal water agency, in conjunction with the U.S. Geological Survey, monitors its secondary source of drinking water, a reservoir, to ensure its long-term environmental health. High concentrations of phosphorus in the sediment, blue-green algal blooms (influenced by nitrate run-off), and construction within the lake's watershed are all areas of concern. During the summer months, the reservoir level can drop by as much as 8.5 feet and taste-and-odor occurrences are not uncommon.

Technology: The agency uses a fixed YSI Vertical Profiling System in the reservoir. The parameters for measurement include water temperature, conductivity, pH, dissolved oxygen (DO), turbidity, chlorophyll, and PAR (photosynthetically active radiation). A YSI multiparameter sonde takes continuous measurements of water conditions throughout the water column and relays the data via satellite to the internet so that water-treatment managers can view the data in near real-time.





A vertical profiling system monitors water quality surrounding an intake structure

Data: The heavy demand for water from July to September requires the city to supplement its groundwater withdrawals with drinking water from the reservoir. Real-time data from the Profiler at the intake structure allows plant managers to choose which intake to draw from. Elevated manganese concentrations in the deeper part of the lake prompt the city to close the lower intake and open the upper intake. (DO concentrations less than 1.0 milligram per liter indicate the increased possibility of elevated manganese concentrations.) Taste-and-odor occurrences caused by algae have been an issue for water pumped from the upper intake and the city closes this intake when chlorophyll data suggests an algal bloom is in progress.

"Dollars & Sense": Real-time monitoring of water quality at the intake allows managers to select the optimal water for withdrawal. Taking this step means that their treatment process is optimized and efficient, saving money on treatment costs and making the best use of a limited supply of water during periods of high demand.

Note: Reference to the USGS in this article does not constitute U.S. Government endorsement of this product.

See YSI Application Note A538 for more details

Customer Class Federal Water Resources Agency
Environment Reservoir
Location Taiwan

Situation: A federal water agency monitors an important drinking water reservoir that is prone to landslides during typhoon season, resulting in very high suspended sediment loads. Two to four times per year turbidity can spike from the usual 40 NTU to the 100,000 NTU range and choke the reservoir's water treatment plant, which is equipped to handle water with no more than 3,000 NTU. Past events had caught water resource managers off-guard, resulting in plant closure and forcing citizens to rely on bottled water during these periods.

Technology: To manage the subsurface turbidity plumes, the agency uses two YSI Vertical Profiling Systems mounted to pontoons at two points in the reservoir. The parameters for measurement include turbidity, chlorophyll, temperature, conductivity, pH, and dissolved oxygen.

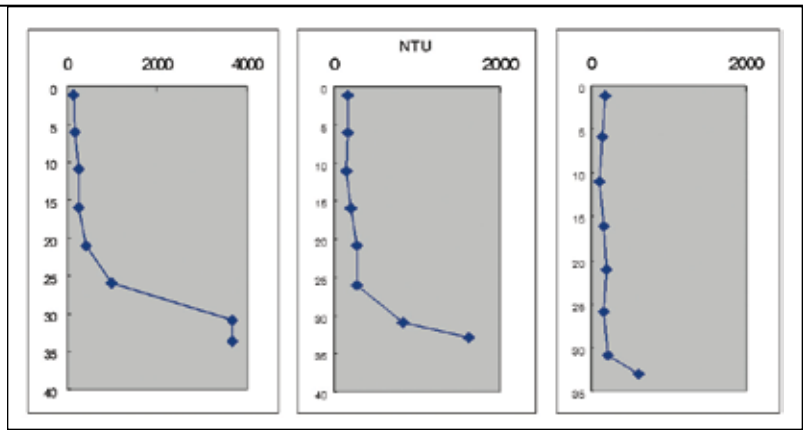
The YSI multiparameter sondes on the Profilers take readings every five meters from surface to bottom and, at three-hour intervals, transmits data via wi-fi back to the treatment plant.

Data: When turbidity reaches critical levels, the data from the Profilers triggers an emergency plan at the water treatment plant. A team of technicians promptly begin a program of manual sampling to confirm the problem and determine its extent.

"Dollars & Sense": Unattended monitoring of the water column helps ensure that intakes are opened and closed to draw clean water and avoid unseen suspended sediment plumes following the typhoons from entering the treatment plant, thus preventing plant closure and costly damage. If turbidity levels are too high, the plant shuts down all intakes and draws water from a backup source in a nearby river, thus avoiding an interruption in the region's water supply.

In addition to turbidity, data from the other water quality sensors provides a valuable data set on the natural variations of water quality within the reservoir.

Profiles at six-hour intervals show high turbidity at the bottom of reservoir due to a landslide, then gradual settling back to baseline levels



See YSI Application Note A552 for more details

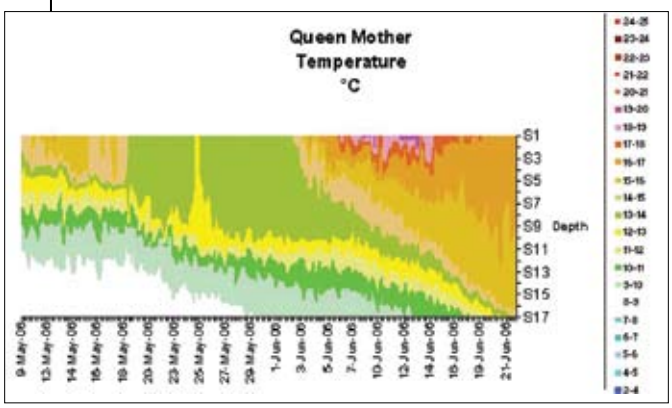
Customer Class Private Water Company
Environment Reservoir
Location United Kingdom

Situation: While the United Kingdom suffered through a serious drought, the country's largest private water company was interested in increasing the efficiency of using its water resources. It holds drinking water in reservoirs with a minimum retention time of 10 days. This naturally affects some aspects of the water quality (sediment settles); however, the company wanted quantitative data to help it select which intakes, within the reservoirs, the highest quality water is located to draw from at any point in time.

Technology: The company chose a YSI Vertical Profiling System, which was installed by YSI on a water tower in the middle of a reservoir outside London. The parameters for measurement include temperature, conductivity, pH, turbidity, dissolved oxygen, chlorophyll, and blue-green algae. For many years, the plant managers had been interested in obtaining continuous monitoring data, but had not been able to find the right system until they found the YSI Profiler.

Above: A fixed Vertical Profiling System installed on a water tower. Below: Temperature data of a water column reveals layers of varying water quality

Data: Plant managers use real-time data to select the best quality water for extraction. Throughout the water column, they look for horizontal layers with low algal loads and low turbidity levels. By identifying and withdrawing this water—which requires fewer chemicals to treat and can be handled more easily by the plant's treatment systems—the company optimizes its treatment process and saves money.



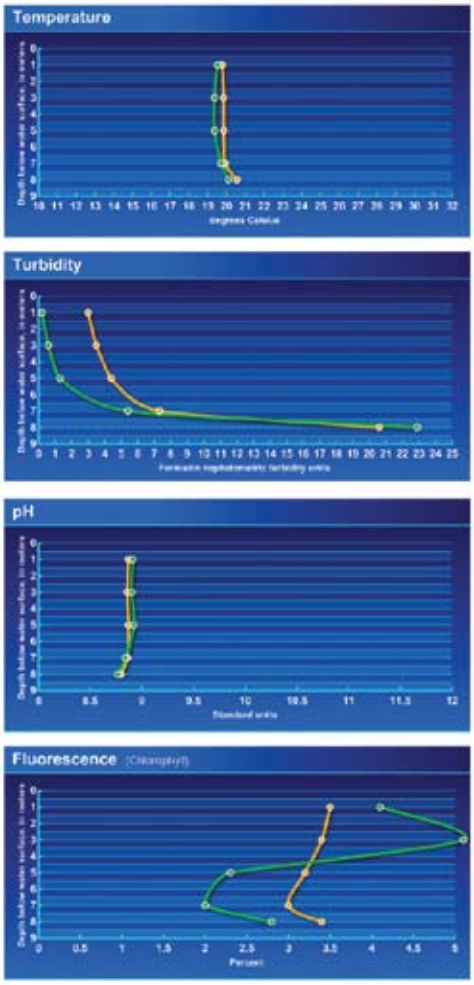
"Dollars & Sense": Based on the success of monitoring the water column in one reservoir, the company installed three additional Profilers at other strategic reservoirs. Each system paid for itself in about one year, in part because the company reduced by half the number of field surveys for manual profiling (less cost for boat and personnel). Additionally, real-time chlorophyll and blue-green algae data guide the managers in suppressing algal growth by using "active mixing" in the reservoir. This includes air jets and aeration, a process which uses energy and increases costs, so the data helps them employ mixing in a timely and efficient manner. (By contrast, lab results for the same data take four days to deliver.)

See YSI Application Note A545 for more details

Customer Class Federal Monitoring Agency
Environment Lake and Reservoir
Location Southwestern Region, USA

Situation: In the U.S.'s driest state, the U.S. Geological Survey (USGS) monitors the state's largest reservoir. Storm water and agricultural runoff, as well as treated wastewater effluent, enter the reservoir from several inflow points. This prompts concern over potential effects to reservoir water quality, such as large blue-green algal blooms—especially since some of the water is subsequently pumped to the municipal drinking water treatment plant.

Technology: The USGS uses four YSI Vertical Profiling Systems throughout the reservoir. Parameters of measurement include dissolved oxygen, pH, turbidity, depth, temperature, specific conductance, and chlorophyll. Additionally, the Profilers collect meteorological data such as air temperature, relative humidity, wind direction and speed, solar radiation, and barometric pressure. All data are downloaded once per day to a USGS site office.



Above: Robust reservoir monitoring tracks impacts of run-off and effluent as well as diurnal variations in water quality with depth . Right: A pontoon-mounted Vertical Profiling System

Data: The large amounts of data collected during continuous monitoring provide insight into the impacts of population growth and construction in the region. Researchers use the data to create a complete picture of the reservoir and surrounding watershed, to validate hydrodynamic computer models, and to help understand the fate and transport of water from the watershed after it enters the lake. Specifically, temperature data from throughout the water column helps to track the variable height of the reservoir's thermocline. By bypassing warmer water when pulling for the treatment plant, the managers avoid water that generally is poorer quality and therefore more difficult to treat.

"Dollars & Sense": As the region's population grows and the municipality acquires more drinking water customers, water quality analysis becomes even more important. The reservoir level is dropping due to high volume usage and reduced inflow, and data provided by the Profilers near intakes helps managers draw in optimal water for treatment, thus reducing treatment costs.

Note: Reference to the USGS in this article does not constitute U.S. Government endorsement of this product.

See YSI Application Note A539 for more details

Customer Class Municipal Monitoring Agency
Environment River and Reservoirs
Location Western City, USA

Situation: A municipal utility district needs to manage its large watershed to meet the growing demand for clean drinking water as well as balance demands for irrigation, long-term storage in case of drought, hydroelectric power, and fish habitat protection. The water supply originates with rain and snow melt in the mountains and flows to a main river and several reservoirs. Drinking water is distributed through a unique aqueduct system.

Technology: The utility collects samples and real-time data from many points. In one reservoir, it uses a YSI multiparameter sonde and in another reservoir it uses a YSI Vertical Profiling System. The parameters for measurement include temperature, conductivity, pH, turbidity, dissolved oxygen, and chlorophyll.

Data: The utility focuses on certain key parameters for different areas of the watershed. pH readings help them determine the amount of lime to add to change the pH of the naturally acidic water before it enters the aqueducts—and thus protect the pipelines from corrosion.

Manual sonde profiles (non-automated) from multiple stations in the reservoir provide a baseline data set of water quality levels and fluctuations over time.

Real-time data from a buoy-mounted Vertical Profiling System (below) helps to monitor the water quality of a large network of reservoirs and aqueducts (above)

And the utility uses the automated YSI Profiler to monitor oxygen levels (as well as several other key water quality parameters) from the top of the reservoir down to the bottom. The Profiler gives them a constant supply of water quality data throughout the water column.

"Dollars & Sense": The utility needs to keep oxygen circulating in the reservoir in order to protect fish species. They feed liquid oxygen into the lake bottom via a hypolimnatic oxygenating system (HOS). Operation of the HOS is efficiently managed and controlled in large part based on the data from the Profiler.

Previously, the staff took samples one to two times per week, generating only a snapshot of the deep reaches of the reservoir. However, with the Profiler, they now have a continuous, detailed picture. Additionally, they collect more data while at the same time reducing the amount of labor required to do this.

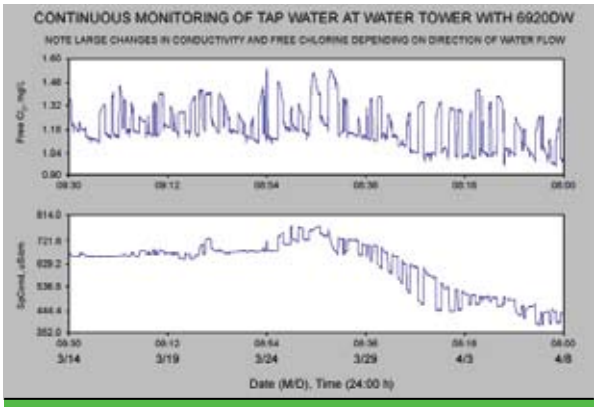
See YSI Application Note A561 for more details

Customer Class Municipal Monitoring Agency
Environment Drinking Water Treatment Plant
Location Midwestern City, USA

Situation: A municipal water utility monitored its treated water inside a water tower. It needed to provide assurances that the quality of the water filling the tower did not degrade during retention and was of the same quality once it was released into the distribution system. This utility serves a region of over one million residents with more than 3500 miles of drinking water pipes.

Technology: The utility conducted a series of studies using the portable YSI 6920DW multi-parameter sonde at a water tower approximately three miles from one of its treatment plants. The sonde was installed with a flow cell tapped off the main water line that went into the tower. Parameters of measurement include temperature, pH, specific conductance, ORP, turbidity, and free chlorine. Data was automatically logged and managed with a YSI 6500 Process Monitor, which connected to the plant's SCADA.

Data: As water moved in and out of the tower, free chlorine changed radically, a pattern which was not observed at the treatment plant. The discrete changes were due to the source of the water, either supplied from the mainline with high chlorine levels or from the tank with lower chlorine levels due to detention time. Additionally, changes were observed for conductivity. This data pattern indicates that high conductivity water was initially pumped into the tank prior to a rainfall event while the lower conductivity water came from the main following rain events.



Above: Data shows variations in free chlorine and conductivity of treated drinking water stored in a water tower. Below: A portable sonde and monitor collects data inside the tower.

"Dollars & Sense": From this monitoring, the utility gained insight into the expected variations in key water quality parameters for drinking water. The data collected reassured the utility that the water provided to residents remained clean and safe after treatment—in the end, neither the free chlorine nor conductivity fluctuated beyond acceptable levels.

See YSI Application Note A530 for more details

Customer Class Regional Water Utility
Environment Drinking Water Intake
Location United Kingdom

Situation: A regional water utility had relied on traditional sampling systems to monitor its riverine source water. As the cost of labor and time for maintenance and calibration of these large, mounted systems increases, the utility investigated new ways of monitoring its source water from rivers without the high costs.

Technology: The utility uses two YSI HydroSAMs for simple intake sampling and monitoring: one at the treatment plant intake and one 10 miles upstream. The heart of the HydroSAM is a YSI multiparameter sonde, a compact water quality instrument designed for long-term deployments. River water is pumped through a single sample chamber, exposing all of the sonde's sensors to the same sample. The parameters for measurement include pH, temperature, conductivity, turbidity, dissolved oxygen, and ammonia. Data is sent to a datalogger, then is sent via telemetry to the treatment plant.

Despite the challenges of in situ *monitoring, such as biological fouling on instruments, the HydroSAM stands up to long-term deployments*

See YSI Application Note A553 for more details

An intake pipe delivers water from the river to the nearby HydroSAM sampling system

Data: The HydroSAMs provides continuous data to the utility. Operators dial in to the unit from the plant, or visit the site and collect data with a portable computer. Alarm conditions are set and the unit issues alarms should those conditions arise.

"Dollars & Sense": The reliable performance of the HydroSAM saves labor costs for the utility. The traditional system required one hour of maintenance almost every day. With average labor costs in the UK at £26 per hour, maintenance costs for a traditional system for one year are around £9,000 (or more than US$18,000).

With the HydroSAM, maintenance and calibration visits are reduced to once every six to eight weeks. This is due mainly to the fact that the sampling system submerges the sensors only when readings are taken. Additionally, the sensors have built-in wipers which remove biological fouling present in the river water, thus extending the length of time the sensors take accurate readings without interference.

Overall, the utility now has a total labor cost of approximately £250 (US$500) per year using the HydroSAM, a significant savings of around £8,750 (US$17,500).

To order or for more information, contact YSI.

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Why Choose YSI?

Reliable data helps you to act quickly, work efficiently, and reduce costs.

You can trust YSI's sensors and systems to provide a continuous and comprehensive data record of water quality and velocity, giving you the information you need to make decisions about your source water.

We understand the challenges of working in natural environments. Our long-term monitoring systems play a key role in improving resource management and plant efficiency—allowing for early warning and rapid response to events such as algal blooms and floods.

Every environment is unique. Talk with our experienced, hands-on application specialists, who can assist you with your specific monitoring needs.

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