Hach NX7500 in Surface Water Monitoring Applications

Problem

Surface sources present particular challenges to drinking water plants. Ever-changing incoming water quality must be monitored, and treatment options must address many factors such as disinfection by-products, coliform treatment, and pH. In addition, fluoride and metals concentrations must be maintained while also removing organics and nitrate.

Solution

Hach®'s new NX7500 scanning UV system provides data from a reagent-less sensor. Measuring parameters such as concentrations of nitrate, Natural Organic Material (NOM), and Total Suspended Solids (TSS), this high-frequency data collection provides real-time information about source water quality, allowing for fast reaction to unexpected fluctuations.

Benefits

Extensive field testing confirmed that the scanning UV sensor data compared reliably with lab-processed grab samples. The NX7500 system provided real-time, continuous, and remotely accessible data, while requiring minimal maintenance and having no reagent costs.

Background

Colorado Springs Utilities' (CSU) Phillip H. Tollefson Water Treatment Plant is a 22 million gallons/day-rated conventional US drinking water treatment plant on the city's west side that takes raw water from multiple reservoirs in the Pikes Peak region, where urbanisation adds to the usual surface water quality challenges.

Among the intake parameters currently monitored by CSU with a combination of lab and online methods are turbidity, pH, TOC/DOC, metals and nutrients. The utilities decided to improve intake monitoring to better understand incoming water quality and make the right treatment decisions that reduce the risk of unwanted issues with the final product.

The new scanning UV technology was suggested for testing at this treatment plant's intake to validate the ability of the reagent-less sensor to provide reliable data with low maintenance and operating costs.

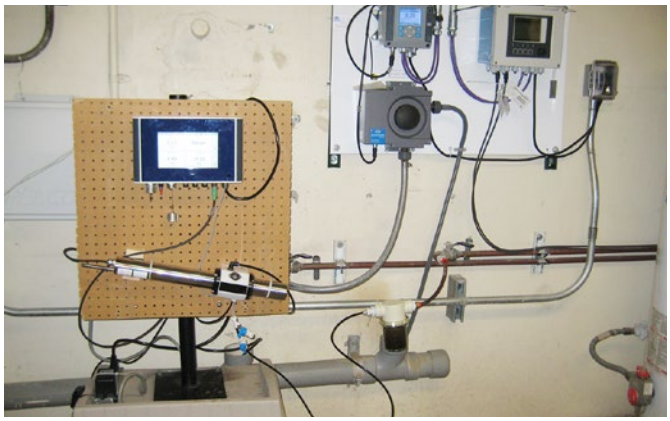

Fig 1: NX7500 and CD500 controller installed for test

Testing the NX7500

The new Hach NX7500 sensor and CD500 controller that comprise the scanning UV system were field tested from May to July 2017 near the main intake pipe, a sampling point shared by the existing equipment measuring turbidity and pH of the raw water (Fig 1). The UV sensor, equipped with a 10 mm optical pathlength, conducted a full UV scan from 200 to 360 nm (0.8 nm step) every 15 minutes and the recorded data were downloaded via USB port on the CD500 controller, processed in Excel and compared against weekly laboratory grab sample analyses.

Comparing Results

The data, collected over 50 days of testing, are presented in Fig. 2. The NX7500 UV system measured concentrations of nitrate and monitored trends for Natural Organic Matter (NOM), as well as Total Suspended Solids (TSS). The scanning UV probe measures organic content at 254 nm reference wavelength, which the software suite can display as DOCeq (dissolved organic carbon) and/or SAC254 parameter. The nitrate concentration is measured directly at wavelengths specific for nitrate/nitrite and expressed in mg/L of the analyte. The parameters marked as equivalent ('eq') normally require calibration against grab sample analysis; however, they can provide reasonable trending information under factory calibration.

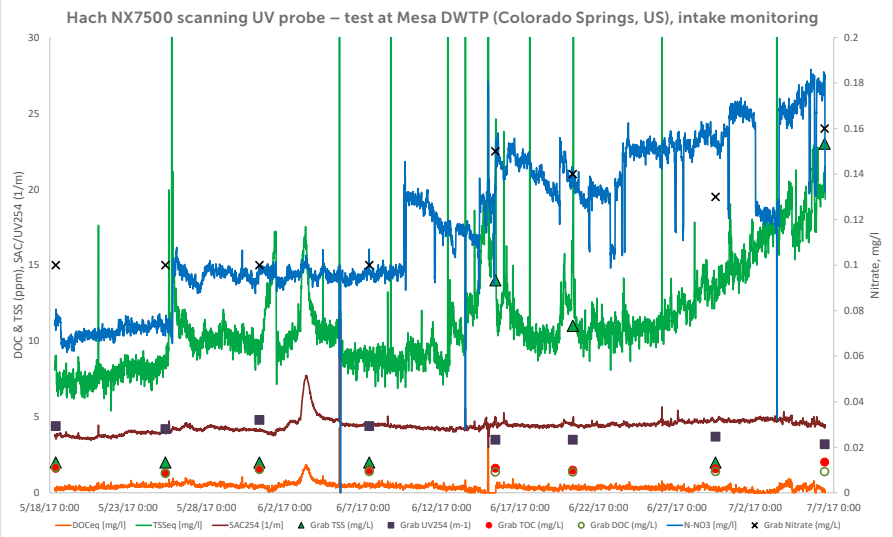

Fig. 2: Single points on chart represent periodic grab samples. Continuous line represents the NX7500 data collection (15-minute intervals).

Nitrate Monitoring

The nitrate test data are presented in Fig.3 and show good correlation with weekly grab sample results. The 75 percent correlation rate was determined from the number of compared pairs (6 of 8) being within the expected discrepancy of ± 0.02 ppm or 15%, whichever is greater, a criterion based on common practice.

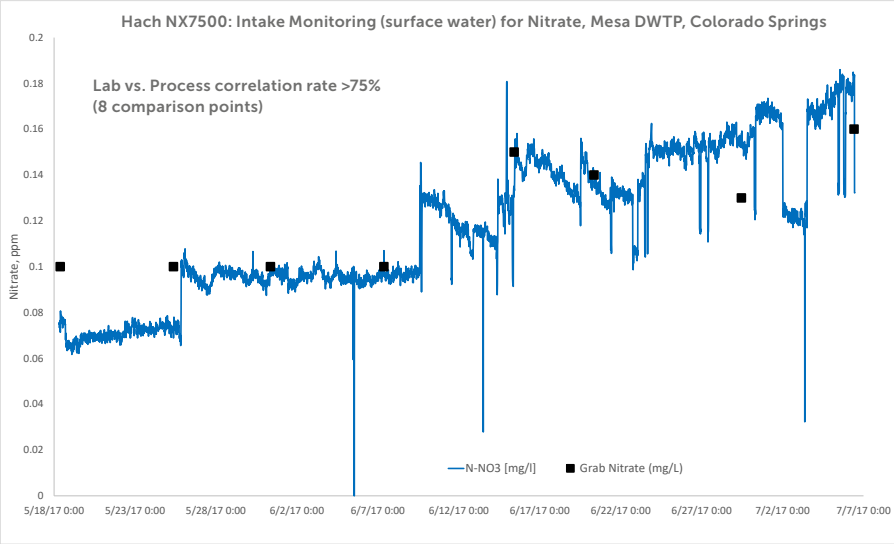

Fig. 3: Visual correlation between process and lab results for nitrate concentration.

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Detailed Comparison

The detailed comparison of process vs. lab results and relevant statistics are provided in Table 1. It should be noted that with only 8 grab samples collected and analysed during the 50-day testing window, and if grab sample analysis is conducted in the field, where sensitivity of some methods to sample temperature can lead to accuracy issues (whereas the scanning UV sensor is not influenced by sample temperature), a 75% accuracy rate should be accepted as satisfactory.

Date	NO_3 Lab, ppm	NO_3 Probe, ppm	Probe vs Lab, ppm	Probe vs Lab, %
5/18/17 9:13	0.10	0.08	0.02	31%
5/25/17 9:04	0.10	0.07	0.03	45%
5/31/17 8:54	0.10	0.10	0.00	0%
6/7/17 9:03	0.10	0.11	0.01	7%
6/15/17 10:08	0.15	0.13	0.02	15%
6/20/17 8:33	0.14	0.14	0.00	0%
6/29/17 11:05	0.13	0.16	0.03	17%
7/6/17 10:10	0.16	0.18	0.02	12%
Average Discrepancy, ppm			0.02* Min delta=	0.00 ppm
Average Discrepancy, %			13%* Max delta=	0.03 ppm

* - Lab method (e.g. TNT835) accuracy depends on sample temperature and may be ±0.02 ppm or 15%, whichever is greater.

Table 1. Comparison of 8 grab samples during the 50-day testing period.

Organics Monitoring

For measuring the concentration of dissolved and suspended organic substances, the NX7500's scanning UV technology brings multiple benefits vs. a single-wavelength monitoring (254 nm), because the full UV spectrum scan interpreted with the right algorithms offers more valuable information, including a more complete correlation between the spectral data and parameters related to organic carbon (DOCeq, TOCeq, BODeq, CODeq). While scanning UV technology has limitations (only organic compounds with double bonds absorbing light in this region are detected), the enhanced capabilities of the full spectrum scan offer more potentially useful data (compared to UV254 technology) at a fraction of the cost of TOC analysers.

Although the organic carbon parameters marked as "equivalent" normally require calibration against grab sample analysis, the continuous monitoring provided by NX7500 should allow for useful trending of organic content in source water with just factory calibration. This continuous monitoring data should allow for both triggering when an established threshold is exceeded and/or, for online monitoring of %TOC removal, when used with one sensor before and another sensor after treatment. The latter is one of the primary goals of drinking water treatment and a measure of the efficiency of the coagulation/flocculation/filtration process.

Because the comparison with grab sample TOC/DOC analysis can yield distorted results under certain conditions (Colorado Springs Utilities reports that it is common to have a dissolved organic carbon reading being higher than the total organic carbon when TOC is almost entirely DOC), no calibration of the sensor was fulfilled in this test.

Interestingly, the NX7500 Sensor did register a significant increase in organics on June 3 that was missed by the weekly grab sample analysis (Fig. 4), demonstrating the benefits of continuous monitoring.

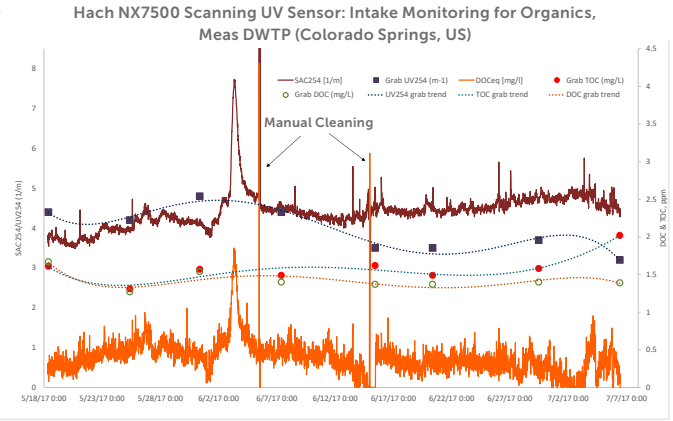

Fig. 4: Influent spike captured by NX7500, missed by periodic grab samples.

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Sensor Fouling Control

The potential for biofouling of the sensor and flow cell was relatively high in this field test, because the water was never disinfected prior to encountering the sensor. Additionally, the CSU personnel decided to remove the 40-mesh filter from the strainer to measure the sample without modification. To verify the sensor's performance and absence of fouling, manual cleaning was conducted twice during the test. The first cleaning was with a bleach solution, the second with a specially developed formulation to address both biofouling and iron/manganese deposits.

Utilities personnel reported no visible fouling before and after the 5-minute cleaning procedure, demonstrating both ease of cleaning and lack of fouling that could adversely affect readings. The sensor monitors itself for fouling through the TSSeq readings that reflect turbidity of the sample and measure optical path fouling. This parameter comes standard in any software suite and is used by the sensor for self-checking, as well as trending turbidity and indicating the need for cleaning.

Controller (above left) indicating turbidity being about average for the test.

Nano-particle coated sensor optics and the flow cell looked visually clean.

Conclusions

- Extensive field testing confirmed the ability of scanning UV technology to provide useful information on both absolute values and/or trending for nitrate and organics in challenging source water conditions.
- The results of nitrate concentration monitoring confirmed the expectation of analytical quality of the sensor data for this parameter.
- High frequency of sampling allows for significantly more information to become visible, which reduces the chances of unexpected fluctuations in the source water quality.
- The reagent-less sensor technology provides an uninterrupted data stream with minimum maintenance requirements, which contributes to the low overall cost of ownership of the NX7500.

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