**PROBLEM**SOLVER

# Going Multi-Barrier

*The city of Versailles, Ind., operates a surface water treatment plant for its drinking water supply. The water source is a reservoir that has variable organics and solids loads depending on weather conditions. The turbidity level is typically between 25 and 100 nephelometric turbidity units (NTU), but due to rain events, it can increase to more than 400 NTU and remain there for more than a day.*

By Daniel L. Willers, P.E.

Prior to 2007, city officials used two conventional packaged treatment units consisting of two-stage flocculation, tube settling and granular media filtration. During normal turbidity conditions, the units performed at acceptable levels. During spiking conditions, however, performance deteriorated and the filter run times were reduced to unacceptable levels. In addition, the existing package treatment units were showing signs of corrosion and required repair or replacement. The city hired the consulting engineering firm R.E. Curry, Inc. to investigate new treatment options that would address these concerns and increase treatment capacity.

## Repair to replacement

Initially, the investigation focused on rehabilitating the existing units to minimize building disruption. A new treatment process, the Trident HS design from Siemens Water Technologies, was considered the best treatment alternative. This design consisted of two-stage clarification and media filtration, followed by ultraviolet (UV) disinfection. The proposed plan would involve removing the interior components of the existing tanks, repairing them and adding new treatment components. This would allow one unit to remain in service while the other was rehabilitated.

The cost of new stainless steel tanks was also compared with that of rehabilitating the existing steel tanks. The difference in cost for the new tanks was close enough to the original estimate that Versailles decided to proceed with the new tanks. The project shifted from rehabilitation to replacement, providing the city new corrosion-resistant tanks for its plant.

## Multi-barrier design

The Trident HS system process consists of tube settling with external sludge recirculation for removal of settling

*Combining two-stage clarification, media filtration and UV disinfection to improve treatment plant performance*

solids, followed by upflow adsorption clarification through a bed of buoyant media and mixed-media filtration for final polishing. All three treatment stages are combined in packaged treatment units. This multi-barrier approach allows the system to dampen variable contaminant loads and increases its net production in a smaller footprint. The smaller footprint allows the UV reactors to be placed within the bounds of the existing equipment pad.

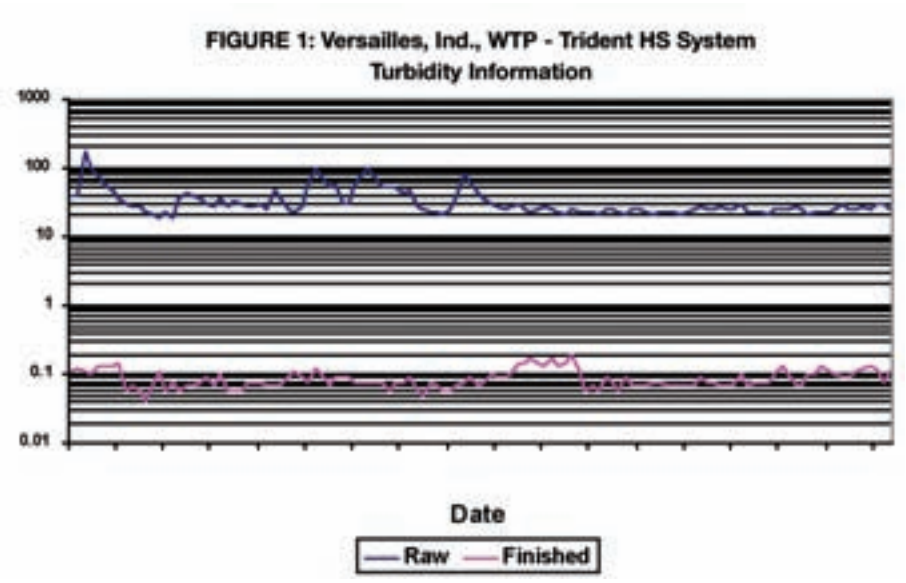
In addition to turbidity, the raw water is high in organics, leading to trihalomethane formation and problems with taste and odor. In order to deal with these issues, the treatment process consists of adding potassium permanganate to the influent water as it enters an existing contact tank. The water is internally recirculated through cascade aerators to add oxygen. Powder-activated carbon is also added as the water passes through a second contact basin.

Influent pumps send the pretreated water through a static mixer, where coagulant and a stream of recirculated sludge are added. At the treatment units, a polymer is fed in to improve particle settling. Chemical doses are controlled automatically by a programmable logic controller working in conjunction with a streaming current monitor. Influent flow control to each unit is performed with a magnetic flowmeter that modulates the influent valve to maintain the flow set point.

The meter also allows flow pacing of the chemical feed systems, and turbidimeters continuously monitor the system performance, matching chemical demand to water quality. This automatic chemical dosing control system reduces operation time and optimizes chemical use, thus reducing overall operation costs. Plant operators are able to adjust set points on the control system's operator interface terminal to ensure proper operation.

## The process

The water first enters the bottom of the tube settler compartment, where the bulk of the solids settle. The sludge concentration below the tube settlers is typically 3,000 to 5,000 mg/L, and it acts as an effective buffer to variable influent solids loads. Because the influent solids concentration is typically




much lower than this sludge inventory concentration, variations in influent solids are dampened by the higher concentrated inventory. This presents a more consistent solids load to the tube settlers, allowing for improved treatment.

Settled sludge is collected from the bottom of the tank using a moving sludge-collection header. A portion of the sludge is returned to the static mixer where it is mixed with the raw water. Returning sludge allows for optimal use of chemicals, increases sludge concentration, moderates solids loading and improves settling. Periodically, sludge is blown down to maintain an appropriate concentration.

Effluent from the tube settlers is collected and pumped upward through the adsorption clarifier system. The buoyant media removes flocculated particles that did not settle in the tube settler. The media is rolled and scarified, which places a rough edge on it to enhance solids capture capacity. Solids are periodically removed by adding air to the bottom of the section, expanding the media bed and flushing solids out of the media.

A mixed-media filter is the final stage of treatment in the packaged unit. Mixed media consists of anthracite, sand and garnet to produce a constantly tightening filter bed. The filter media is directly retained on a laser-cut, stainless steel retainer to eliminate support gravel layers. The filter is backwashed using air and water simultaneously to thoroughly clean the media. Backwash water is collected with a low-profile washtrough specifically designed to prevent media washout with an advanced baffling and solids separation design. After going through the mixed-media filter, treated water is sent to a UV disinfection system and then to the clear well for chlorination.

## Results

The new treatment system was designed for a flow rate of 575 gpm using a two-tank package treatment system. The two-tank system was required as the first new tank was installed adjacent to one of the existing tanks. Once the first unit was fully installed, it was brought online to provide water to the city while the old system was removed. This space was then used for the installation of the second tank. Minimal site painting was required because the new tanks were constructed of stainless steel.

The first unit was placed online in December 2006. Shortly thereafter, the raw water turbidity spiked to more than 425 NTU after a rain event. During this spike, the filtered water turbidity remained less than 0.1 NTU.

"The plant runs like a champ," said Superintendent Kevin Hensley. "The water goes in murky and comes out completely clear."

The average influent turbidity was 35 NTU from March to June 2007 (Figure 1). Daily turbidity spikes during this time have been as high as 169 NTU. During normal operation and spiking conditions, the coagulant feed is automatically adjusted to follow raw water requirements. Throughout this time, the finished water quality has remained very good, with finished water turbidity at an average of 0.09 NTU and a maximum of 0.2 NTU.

The Trident HS system provides high net production from raw water that is high in solids. Typically, the waste stream from each of the clarifier stages equals 1 to 2% of the incoming flow, with the adsorption clarifier system flush cycle taking place every four to eight hours. The extremely high solids removal from the clarification stages allows long filter run lengths of up to 90 hours. Total waste volume for the plant is typically 3 to 6% of the influent flow. WWD

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