

# Multi-barrier Treatment Plant Improves Performance on Variable Water Source

## Problem

The City of Versailles, IN operates a surface water treatment plant for their drinking water supply. The water source is a reservoir that has variable organics and solids loads depending on weather conditions. The turbidity is typically between 25 to 100 NTU, but due to rain events, can increase to over 400 NTU and remain there for more than one day. Prior to 2007 they used two conventional packaged treatment units consisting of two-stage flocculation, tube settling and granular media filtration. During normal turbidity conditions, the units performed to acceptable levels. However, during spiking conditions, performance deteriorated and the filter run times were reduced to unacceptable levels. In addition, the existing package treatment units were showing signs of corrosion, requiring repair or replacement. The City hired the consulting engineering firm of R.E. Curry, Inc. to investigate new treatment options to address these concerns as well as increase treatment capacity.

## Solution

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 as 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 the tanks and adding new treatment components. This would allow one unit to remain in-service while the other was rehabilitated. Once rehabilitation was completed, the remaining tank would be rehabilitated.

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

The Trident HS system process consists of tube settling with external sludge recirculation for removal of settling solids, followed by upflow adsorption clarification through a bed of buoyant media, and lastly, 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 system net production with a smaller footprint. The smaller footprint, compared to the existing treatment units, allowed the UV reactors to be placed within the bounds of the original equipment pad.

In addition to turbidity, the raw water is high in organics, leading not only to trihalomethane formation, but 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 to the water supply. Powder activated carbon is also added as the water passes through a second existing 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 to improve particle settling. Chemical doses are controlled automatically by a Programmable Logic Controller (PLC) working in conjunction with a streaming current monitor. Influent flow control to each unit is performed with a magnetic flow meter, which modulates the influent valve to maintain the flow set point. The meter also allows flow pacing of the chemical feed systems. In addition, 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 system operating costs. Plant operators are able to adjust set points on the control system's Operator Interface Terminal (OIT) to ensure proper operation.

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 3,000-5,000 mg/L, which acts as an effective buffer to variable influent solids loads. Since the influent solids concentration is typically much lower than this sludge inventory concentration, variations in influent solids are dampened by the highly concentrated inventory. This gives a more consistent solids load to the tube settlers, allowing for consistent treatment. Settled sludge is collected from the tank bottom 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 the appropriate sludge 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 the media to enhance solids capture capacity. Solids are periodically removed by adding air to the bottom of the section, expanding the media bed and flushing the 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 media retainer to eliminate support gravel layers. The filter is backwashed using simultaneous air and water 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 the mixed media filter, the treated water is sent to a UV disinfection system and then to the clearwell 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 on-line 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 on-line in December, 2006. Shortly after, the raw water turbidity spiked to over 425 NTU after a rain event. During this spike, the filtered water turbidity remained less than 0.1 NTU.

Superintendent Kevin Hensley summed up this new experience, "The plant runs like a champ. The water goes in murky and comes out completely clear."

As shown in Figure 1, the average influent turbidity was 35 NTU from March through June of 2007. 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.

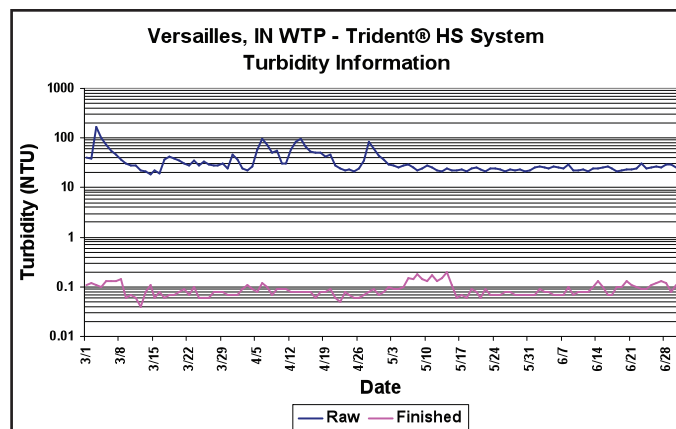


Figure 1: Operating Data for Versailles, IN (March-June, 2007)

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 1-2% of the incoming flow, with the Adsorption Clarifier system flush cycle every 4-8 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 3-6% of the influent flow.

To date, the new Trident HS treatment units have provided exceptional treatment results under a variety of water quality conditions. Multi-barrier treatment and stainless steel construction will allow the plant to address current and future regulations for years to come.

### About the Author

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