The next step in ozone purification

An early adopter adds high-capacity pretreatment to remove almost all particles and algae before filtration.

By Peter Tunnicliffe, PE

Variable-flow software lowers costs by automatically regulating flow into the dissolved air flotation tank through dual saturators Photos: CDM

Who: United Water New Jersey
Where: Borough of Haworth
No. customers: 800,000
Technology: High-rate dissolved air flotation (DAF)
Cost: $100 million
Project delivery method: Design-build
Results: Completed seven months early and $4 million under contracted price

In 1989, United Water New Jersey's Haworth plant was one of the first nationwide to incorporate ozone — a chemical-free purification process that recycles oxygen back into the atmosphere — into its process treatment train. While the newly emergent technology resolved complaints regarding taste and odor, two decades later managers faced another challenge: the public's focus on the environmental impact of infrastructure operations.

The state had mandated that the 200-mgd plant cease sludge decanting discharges to the Oradell Reservoir before Oct. 1, 2009. It also needed to upgrade to comply with the disinfection byproduct limits of EPA's Safe Drinking Water Act. In June 2007, the company launched a project designed to meet these new regulations, improve water quality, and ease operations. At $100 million, it's the largest single capital investment in the company's 140-year history.

The 2-billion-gallon reservoir's water is highly variable: turbidity ranges from 1 to 20 nephelometric turbidity units (NTUs) and the algae counts ranged from 300 to 40,000 units. After examining several alternatives, a year-long, 0.5-mgd demonstration plant confirmed that ozone, high-rate dissolved air flotation (DAF) pretreatment, chlorine disinfection, and filtration would be the optimal solution. Today, the combination of ozone and DAF pretreatment processes increases the plant's historical filter run periods by four to six times, reducing energy consumption and backwash water volumes. In addition, ozone disinfection boosts DAF performance by up to 50%.

The three existing sedimentation basins were converted for use as intermediate disinfection, reducing the plant's hypochlorite usage and associated operational costs by 20%. But the centerpiece of the upgrade is the high-rate DAF sedimentation clarification process, the largest system of its kind in the nation.

This pretreatment stage occurring after ozonation and before chlorination (see diagram above) removes more than 90% of particles and algae from source water before it's filtered. Dual saturators — another design first — lower costs by allowing for seasonally varying flow rates into the DAF tanks.

The high-rate DAF process requires one-eighth the process tank volume needed for traditional sedimentation clarification, allowing the owner to conserve 12 acres of woodlands. Considering site restrictions for the new facilities, this was a key factor for the project's viability.

Recently passed state legislation to guard the state's open waters limited any changes in facilities or land use within 300 feet of the reservoir and a

natural brook that runs through the site. To avoid disrupting residential neighborhoods during construction, the site wasn't accessed through the existing plant; instead, a separate entrance — which needed to avoid interference with an existing 16-inch gas main and sensitive wetland areas — was negotiated with the local community.

To further optimize space, high-concentration, high-efficiency ozone generators (10% ozone by weight gas stream, and ozone produced using less than 4.6 kilowatt-hours per pound of ozone) were installed within the existing equipment's footprint and building space, saving more than $3.5 million. Careful attention to the sequence of construction was critical to maintaining operations as the new ozone generators and associated piping were installed in phases in the existing ozone generation building.

The new unit processes — ozone and DAF pretreatment — were to be inserted hydraulically between existing raw water and existing filter basins. With only 1.5 feet of available hydraulic head in the existing plant's process at 200-mgd peak flow conditions to work with, designers used computational fluid dynamics (CFD) modeling software to devise a solution that evenly split the incoming raw water flow through the four new ozone contactors and 10 new DAF basins. Each ozone contactor can now treat and hydraulically pass 66 mgd; each DAF can treat and hydraulically pass 21 mgd.

Using modeling in the design avoided having to rebuild the entire raw water pumping system, resulting in further capital savings of $4 million to $6 million.

In addition, approximately 25% of the upgrade's final design was prepared in 3D, including the residuals processing components, which helped reduce conflicts and minimize changes during construction.

FAST-TRACKING PUBLIC, REGULATOR ACCEPTANCE

Customers didn't lose a day of service during construction — a tremendous feat for a project of such magnitude — but with the plant

located in a residential area, the design-build team also had to minimize noise and traffic disruption.

The project employed more than 400 carpenters, laborers, ironworkers, pipe fitters, electricians, and other construction trades people.

To meet the contracted 34-month timeline, the design-builder implemented its proven quality management protocols, including a project-specific comprehensive plan that incorporated all critical planning documents and established the processes for safe, coordinated teamwork in delivering the specified level of quality with the design-builder, the subcontractors, and client team members.

Recognizing that daily operations at the jobsite significantly influence success of any project, CDM assigned two full-time engineers to work with the owner's full-time project manager, an overall project manager familiar with both design and construction, and an operations specialist to coordinate the function of existing facilities and the phased commissioning of the new unit processes.

Using design-build project delivery meant designers could concentrate on the plans and specifications necessary for the intended sequence of construction. By using early-release design packages, initial design focused on the foundation needs, and construction site mobilization began three months after notice to proceed with the design. Similarly, major process treatment units were designed, permitted, and constructed ahead of schedule.

Routine meetings by the integrated project management team ensured that extra steps were taken to reduce energy and eliminate waste. Early and close collaboration with environmental regulators ensured that the project embraced all environmental regulations.

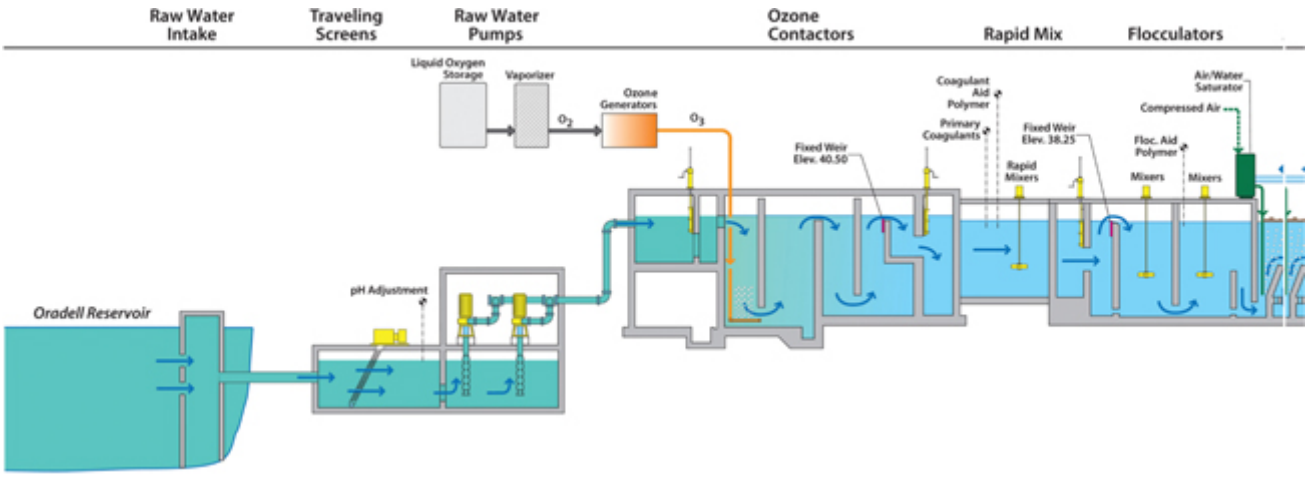
Today, United Water uses the plant to educate the community about sustainability as well as drinking water treatment.

When they tour the plant, students and residents learn why the water that flows from their kitchen and bathroom faucets tastes so good. Corridors are lit with energy-efficient fixtures, and the process tanks and new buildings are made partly from recycled material, with fly ash in the concrete and recycled steel for reinforcement.

When they reach the flotation building, they learn about another energy-saving measure: Rather than heating the entire 25,000-square-foot facility with its open water surfaces, heat from blower pumps and electrical gears keeps components from freezing and spot-heats certain areas so

operators work comfortably.

Did you know ... ?
New Jersey has one of the highest percentages nationwide of privately water, and companies may apply for the federal- and state-seeded portions of the state's revolving loan program.



High-rate dissolved air flotation reduces the 200-mgd operation's backwash volume from 8 recycled to the plant's intake as raw water, eliminating discharge to the reservoir and savin