Treatment
with a Side of Education

Loudoun County's Broad Run Water Reclamation Facility (BRWRF) in Ashburn, Va., not only discharges wastewater that is cleaner than water drawn from the Potomac River, it also enables commercial customers to reuse wastewater, thereby reducing demand on freshwater resources. The state-of-the-art plant is easily expandable to handle projected growth and is the centerpiece of a long-range plan to meet future Chesapeake Bay watershed water regulations, which are likely to be stricter than current requirements.

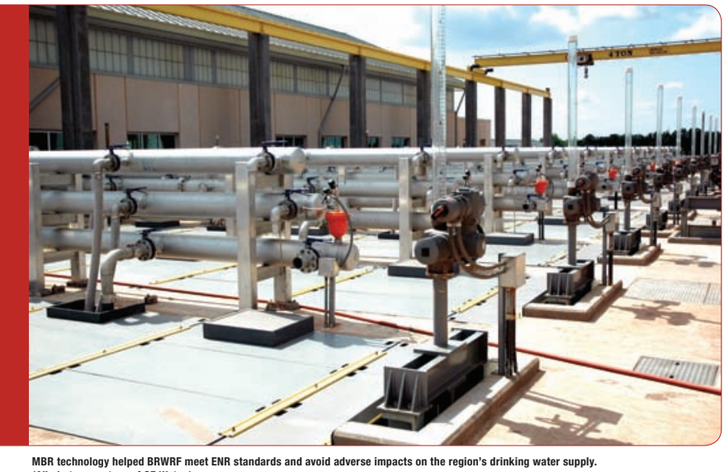
By Deo Phagoo & David Brink

MBR technology helps Loudoun County, Va., meet strict discharge requirements and reuse wastewater

The BRWRF is the first large-scale wastewater treatment plant to use a combination of GE ZeeWeed membrane bioreactor (MBR), granular activated carbon (GAC) and ultraviolet (UV) technologies to meet enhanced nutrient removal rules. Odor-free and situated in a campus-like setting with inviting indoor/outdoor information exhibits, the facility also serves as a valuable community educational resource on water use and conservation.

The facility is owned and operated by Loudoun Water, the county authority that provides water and wastewater services to some 185,000 users in eastern Loudoun County, about 25 miles from Washington, D.C., and home to Dulles International Airport. For years, the eastern portion of the county had sent all of its wastewater to the Blue Plains Advanced Wastewater Treatment Plant in Washington; however, the D.C. Water and Sewer Authority limits the wastewater flow that can be sent to Blue Plains to 13.8 million gal per day (mgd).

With county growth projections predicting a doubling population within the service area, Loudoun Water decided to build the BRWRF to provide county residents with a long-term wastewater reclamation solution.



MBR technology helped BRWRF meet ENR standards and avoid adverse impacts on the region's drinking water supply. (All photos courtesy of GE Water.)

Design Challenges

In selecting an appropriate water treatment technology and process, Loudoun Water planners and design engineers faced two major challenges. The first was that Virginia, along with five other states sharing the Chesapeake Bay watershed, has agreed to enhanced nutrient removal (ENR) standards to improve water quality, reduce algal blooms and restore aquatic habitats in the Chesapeake Bay—North America's largest and most biologically diverse estuary. The Broad Run is part of that watershed, so engineers had to select a system that could comply with the tough ENR standards.

"We have met very stringent permit requirements from the day we opened in May 2008—a major accomplishment given the Chesapeake Bay preservation effort that drove the requirements," said Thomas Broderick, program manager for the Broad Run facility. "Phosphorous is of particular concern because it is a nutrient that promotes algae growth. Thanks in large part to membrane technology, effluent from the BRWRF contains just 0.1 ppm of phosphorous, one-third the level most other wastewater treatment plants in the Chesapeake Bay watershed are allowed to discharge. In fact, the Potomac River itself has higher phosphorous levels than our effluent, so in this respect we are returning cleaner water than we are taking in to make drinking water."

Another challenge engineers faced was the discharge location in the Broad Run. The Broad Run is a tributary of the Potomac River. It empties into the river about five miles downstream of the BRWRF's discharge. But another five miles downstream from there, in the Potomac itself, is the intake for a large drinking water treatment plant that provides water to Loudoun County and other jurisdictions in the northern Virginia region. Thus, a robust wastewater process producing high-quality treated effluent under all conditions was required to avoid adverse impacts on the region's drinking water supply.

Stringent permit requirements for the BRWRF include:

- Carbonaceous oxygen demand (COD): 10 mg/L
- Turbidity: 0.05 NTU
- Total phosphorous (TP): 0.1 mg/L
- Total nitrogen: 4 mg/L
- Total Kjeldahl Nitrogen: 1 mg/L
- *E. coli*: 2 counts/100 mL. By comparison, the allowable limit for most wastewater plants is 126 counts/100 mL.

The award-winning facility includes an attractive brick panel design, extensive odor control, a visitor information center called the Aquiary and park-like landscaping.

MBR Technology

"We evaluated membrane technology as well as several conventional treatment alternatives such as high-lime and multipoint alum addition," Broderick said. "In the end, we went with MBR technology. Not only was it cost-competitive with other options in meeting these requirements, it was positioned more directly than the alternatives at the specific issue we were trying to address, namely protecting human health. With MBR we could build a system with multiple pathogen barriers. It also offered a reduced plant footprint and fewer unit processes."

The system allows wastewater to be reclaimed and reused. "Right now we are using some of the treated effluent in the plant itself for process water and for nonpotable uses such as flushing toilets," Broderick said. "Later this year, we will connect with our first commercial customer for reclaimed water—a data center that will use it for cooling. We have one other customer lined up that will use the water for irrigation, sprinkler fire suppression and toilet flushing."

Loudoun County moved early on to engage the community, and the BRWRF's water reclamation capabilities have struck a chord with the public.

"We knew the wastewater was going to be clean enough to be reused. We wanted to encourage that activity and also to show off the plant, so we asked a number of community groups to advise us on how best to do that," Broderick said. "The result is a visitor information center we call the Aquiary, which consists of an indoor exhibit area and an outdoor interpretive area. It provides the public with an opportunity for hands-on exploration of how water is treated, used, reclaimed and conserved within the county."

"We also paid a lot of attention to landscaping, and the grounds are park-like," he continued. "The community also gave us feedback on architectural designs, and the building has an attractive brick-and-precast panel design that fits in with the surrounding area. It also features complete odor control. Our basins are covered, and any odorous air is pulled off and treated."

Process Overview

GE Water participated in a 2001 pilot study of MBR technology conducted by Loudoun Water and engineering builder/contractor CH2M HILL. The study demonstrated that the proposed treatment process would meet the required effluent quality, and it also provided data to help optimize the full-scale process design. A competitive bidding process followed the pilot study, and GE Water was selected to provide ZeeWeed MBR technology.

Designed by CH2M HILL, the BRWRF incorporates coarse screening, grit removal, primary clarification, biological treatment, ZeeWeed ultrafiltration (UF), GAC and UV disinfection. The plant is the first-ever large-scale application of the MBR/GAC/UV treatment combination. The GAC step is included to polish organics from the MBR permeate in order to meet the 10 mg/L COD discharge criterion. This step also provides a robust process to reduce effluent biological oxygen demand to below detectable levels.

The ZeeWeed immersed UF membranes form the basis of the MBR system and provide efficient solid/liquid separation. They filter out virtually all solid particles, bacteria and other pathogens. The modular, cassette-based system achieves nutrient removal through the use of biological and chemical treatment processes. Biological treatment is based on a modified five-stage Bardenpho process, enabling the removal of both nitrogen and phosphorus compounds. Alum is used to maintain the effluent TP concentration below the 0.1-mg/L limit.

Loudoun Water took advantage of the modular expandability that a ZeeWeed system offers by building additional space into the facility's 12 treatment trains for future expansion. The spare tankage can be filled with cassettes on an as-needed basis to increase capacity. The BRWRF's initial phase provides an average treatment capacity of 5 mgd and uses two membrane cassettes in each train, but as required, two more cassettes per train can be added, bringing the average treatment capacity to 10 mgd.

Award-Winning Plant

In recognition of the state-of-the art facility, the American Association of Environmental Engineers awarded designer CH2M HILL its 2009 E3 Design Grand Prize. The award says the plant "sets a new worldwide technology standard for water reclamation and also provides a community amenity that will have long-lasting educational, aesthetic and recreational value." WWD

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