# Treatment **for the Troops**

Well water quality at army base creates unexpected challenges

**By Randy Leathers**

Uncle Sam and the U.S. Army recently called for an enlistment, but not in the traditional sense. This time, they needed to design and install a complete potable water treatment system for the U.S. Army Corps of Engineers at the Ft. Stewart army base in Savannah, Ga.

Increased potable water demands at the base required rapid construction of a new water treatment plant, and the army called upon WaterProfessionals to install it. The treatment system, which has a flow rate of 600 to 800 gal per minute (gpm), was designed to treat well water to bring it into compliance with U.S. Environmental Protection Agency (EPA) drinking water standards.

## System Design

The original design and specifications were based on limited data about the underground aquifer that was believed to underlie the proposed well site at Ft. Stewart. Key parameters used in the design were 1,500 to 2,000 ppm total dissolved solids (TDS), 20 to 25 ppm silica, 100 to 175 ppm alkalinity and 290 to 320 ppm sulfate. Total hardness and barium projections were not provided.

Because the TDS level was significantly higher than the secondary EPA drinking water limit of 500 ppm, reverse osmosis (RO) was selected as the primary treatment technology. Based on projections about the aquifer, the TDS limit could be met by treating approximately 75% to 85% of the well water with RO and blending it with 15% to 25% untreated well water. The blended TDS would be below 500 ppm.

## Suprising Results

When the well was drilled, analytical testing following sustained initial pumping showed the following: 1,032 ppm (60 grains per gal) total hardness, 1,160 ppm sulfate (as $CaCO_3$) and 1,127 ppm TDS. The unanticipated hardness and sulfate concentrations posed a challenge for the RO system.

Because RO membranes allow water to pass through while rejecting dissolved minerals, the "dirty" side of the membrane is subjected to the concentrated waste, or brine, which results from 98% to 99% of the minerals being concentrated into only 25% of the RO feedwater. At this concentration, many minerals with low solubility, such as sulfates, precipitate and form scale on the membrane.

The design anticipated sulfate concentrations of only 290 to 300 ppm, which could be controlled using chemical antiscalents. These are nontoxic, typically organic compounds that can be metered into the RO feedwater in low concentrations to interfere with the crystallization of insoluble compounds to minimize scaling.

The rapid evolution of antiscalent technology in the last decade has eliminated the need to soften RO feedwater in many applications. Utilization of antiscalents eliminates the capital cost for softeners and the operational cost of salt. The sulfate and hardness levels in the base's well water, however, pushed the outer limits of scale minimization using antiscalents alone.

Scaling results in frequent membrane cleanings and reduced membrane life (the RO membranes in this installation have an estimated replacement cost of $115,200), so softening 50% of the well water and blending it with untreated water upstream of the RO membranes was recommended. Because the original design did not anticipate this need and the membranes had been delivered and installed, the new softener system had to be designed to accommodate limited space in the existing water treatment building. Utilizing two large softeners was not an option, and adding another building was cost prohibitive.

## Softening Solutions

A triplex system utilizing three 84-in.-diameter softeners, each containing 120 cu ft of cation exchange resin, were delivered and installed. The softeners consume 10,180 lb of salt per day, so a 12-ft-by-21.5-ft brine silo also was installed. The silo allows pneumatic transfer of loose, bulk salt from a semi-trailer of 40,000 lb of salt at a time. Based on a level control, brine is generated by water sprayed above the salt bed, which then runs through the salt into a sump at the bottom of the silo. The brine is pumped to the softeners during regeneration.

**Bob Brunke, vice president of operations for Culligan Intl., and Earl Gardner, manufacturing manager for Culligan, with one of the system's 300-gpm RO units. Culligan manufactured the equipment used at the base.**

In order to treat the required 300 gpm continuous and 600 gpm peak flow of RO water, and to allow for some redundancy for the potable water plant, two 300-gpm RO units were installed. Each skid-mounted system has 12 RO membrane housings, each containing six 8-in.-by-40-in. thin film composite membranes. Each system has a variable-frequency-drive-controlled 100-hp pump capable of pressurizing 400 gpm of water to an average pressure of 263 psi. A control valve regulates pressure through the membranes. The recovery of each RO skid is 75% with a permeate flow of 305 gpm and a waste flow of 100 gpm.

Pretreatment equipment upstream of the RO membranes includes the following: chlorine injection skids at the well head, triplex water softeners, triplex multimedia filters and bisulfite injection and antiscalent injection skids to destroy the chlorine and help protect the membranes from scaling.

Downstream treatment includes a chemical injection skid for pH adjustment (due to dissolved carbon dioxide and low TDS in the RO water, it has a pH of approximately five), a post-chlorination skid, a fluoridation skid and a chambered clear well to allow chlorine contact time. Duplex variable frequency drive service pumps pump water from the clear well to the elevated water tower.

## Tight Timeline

Not only were the engineering and design specifications exceptionally demanding, the system installation timeline imposed extreme constraints. Part of the vendor selection process was based on the ability to deliver a complete system within a stringent time frame.

Because the project was already behind schedule before the contract was awarded, the WaterProfessionals team had less than two weeks to provide complete submittals during the December holidays and a pressing 12-week delivery deadline, which is about half the time a job of that magnitude would ordinarily require.

The preliminary process required submitting plans stamped by a licensed engineer and generating submittals for review by the Army Corps of Engineers and the state of Georgia with little room for error or revision. The WaterProfessionals team was able to provide a complete package for the review process, and get the system up and running on time, despite several unexpected logistical problems.

WaterProfessionals recommended a solution that softened 50% of the raw water stream to reduce costs, while also lowering hardness concentrations to a level that made antiscalents effective. The original intent to blend raw water with the RO permeate may be limited, if not abandoned, because the well's high sulfate level limits blending the raw well water to less than 15% of the total flow in order to meet the EPA drinking water standard of 250 ppm. Even with sulfates less than 250 ppm, sulfate-related odor issues may cause blending to be aesthetically undesirable.

After working under severe time constraints and with a challenging raw water supply, WaterProfessionals provided a reliable treatment scheme that created finished well water meeting EPA and state of Georgia standards. *wqp*

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