New North Miami Beach Water Treatment Plant Provides Timely Drought Relief in South Florida

Kelvin L. Baker, Martin King, Karl C. Thompson, Mark Perkins, and "Jeff" Huren An

North Miami Beach Water Utility

The city of North Miami Beach's water system is the second largest in Miami-Dade County, with infrastructure of water supply, treatment, storage, transmission, and distribution. The water system provides services to approximately 32,800 metered connections in North Miami Beach, Sunny Isles, Miami Gardens, Aventura, and a portion of Northwest Miami-Dade, serving a population base of over 170,000.

To serve all its customers with its own water, and to provide superior water quality to all its customers, North Miami Beach initiated a water treatment expansion program. Before the expansion, the city owned and operated the Norwood-Oeffler Water Treatment Plant, a traditional lime softening plant with a treatment capacity of 16 million gallons per day (MGD). Approximately 12 to 14 MGD was purchased from Miami-Dade Water and Sewer Department through eight interconnections to meet demand.

The water treatment process includes lime softening to reduce hardness and to remove iron and color, followed by stabilization, filtration, and disinfection. Treatment also includes adding polymer to aid the lime softening process, polyphosphate for corrosion control, and fluoride for dental health. Disinfection is achieved by chloramines, with ammonia added before chlorine. The finished water meets or exceeds current local, state, and federal regulations.

The raw water was supplied by 12 Biscayne Aquifer wells, ranging from 40 to 100 feet deep. The wells are located at the Norwood Wellfield, including seven wells located on the water plant site and five wells offsite in nearby schools and public parks. The capacity of these wells ranges from 0.6 to 6 MGD, with a total capacity of 27 MGD. These wells are rotated on regular basis.

Treatment Plant Expansion Program

Phase I of the expansion project increased treatment capacity from 16 MGD to 32 MGD. After conducting careful feasibility studies and evaluations, the city decided to keep the existing lime softening process and expand the plant using state-of-the-art membrane technology. Foreseeing limited water resources from traditional Biscayne Aquifer water, the city added the deeper Floridan Aquifer as another raw water source.

Initial capacity for the membrane treatment system is 15 MGD, which includes 9 MGD of nanofiltration and 6 MGD of low-pressure, reverse osmosis treated water. The system is expandable to 20 MGD, with an additional nanofiltration train of 3 MGD and additional reverse osmosis membranes for 2 MGD.

The permeate flow streams of the membrane processes are combined for post treatment/stabilization and subsequently blended with finished water from the existing lime softening process and the filtered raw water blend. The blended finished water is then transferred to a new 4.2-million-gallon storage tank and existing 2.0-million-gallon ground storage tanks before it is pumped out to the water distribution system.

Figure 1: Newly Improved Norwood-Oeffler Water Treatment Plant

The new membrane plant was completed in March 2008. Figure 1 shows the front entry of the newly improved Norwood-Oeffler plant.

The wellfield was also expanded to provide a reliable capacity for the new membrane treatment facility. Five new Biscayne Aquifer wells, each with a capacity of 2,600 gallons per minute, and four new Florida Aquifer wells, each with capacity of 2,500 gallons per minute, were constructed. The new Biscayne Aquifer wells will serve only the new nanofiltration system, and the new Florida Aquifer wells will serve only the low-pressure, reverse osmosis system. Raw water from the existing wells will continue to serve the lime softening process.

The concentrate from the membrane treatment process is disposed of by a new deep injection well system. Back-up for the concentrate disposal is existing sewer system.

A significant change was made in disinfectants. The existing system had a chlorine room with capacity to store 10 one-ton gas chlorine cylinders. The city constructed a chlorine scrubber to meet the requirement of the Environmental Protection Agency's risk management plan in 1998, but the plant is located directly in a residential neighborhood with an elementary school as a direct neighbor, so in light of the terrorist attacks that happened on September 11, 2001, the city decided to switch the disinfection system from gas chlorine to bulk sodium hypochlorite.

A new integrated security system was

Continued on page 6

Kelvin L. Baker is the city manager of North Miami Beach. Martin King, P.E., is the city's director of public services. Karl C. Thompson, P.E., and "Jeff" Huren An are assistant directors with the city's public services department. Mark Perkins is the department's public information officer.

Figure 2: New 31,500 Square-Foot Norwood Water Treatment Plant Process Building

Table 1: Typical Biscayne and Floridan Raw Water Quality

Parameter	Biscayne Water (mg/l)	Floridan Water (mg/l)
Ph	7.2	7.5
Total Alkalinity(as $CaCO_3$)	195	140
Total Dissolved Solids (TDS)	405	3800
Total Hardness (as $CaCO_3$)	215	1030
Total Iron (Fe)	0.3	<0.1
Nitrate (as N)	<0.1	<0.1
Calcium (Ca)	83	180
Magnesium (Mg)	1.7	140
Chloride (Cl)	40	2000
Fluoride (F)	0.2	0.1
Sulfate (SO_4)	21	300
Sulfide (S^-)	--	1.3
Hydrogen Sulfide (H_2S)	<0.1	1.0
Color	35	<1

Table 2: Target Nanofiltration and Reverse Osmosis Permeate Water Quality

Parameter	Biscayne Water (mg/l)	Floridan Water (mg/l)
Ph	7.2	7.5
Total Alkalinity(as $CaCO_3$)	195	140
Total Dissolved Solids (TDS)	405	3800
Total Hardness (as $CaCO_3$)	215	1030
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Continued from page 4

installed with the plant expansion. An eight-foot, precast concrete panel screen surrounds the entire site with the exception of areas facing the operations building. Access to the plant is gated and has manned security. The security system includes a facility security monitoring system workstation and associated security equipment, field controllers, card access equipment, and intrusion detection equipment. The monitoring system is also installed to offsite wells.

New WTP Provides Relief from Continuing Drought

South Florida has been experiencing a severe drought since the spring of 2007. In January 2008, the entire South Florida Water Management District (SFWMD) was placed under strict Phase III water restrictions for the first time in the agency's history, directly affecting more than 5 million South Florida residents and thousands of farms and businesses. Residential landscape irrigation was limited to one day a week to conserve regional water supplies. As of April, the restrictions were eased to a twice-a-week landscape irrigation schedule. The water management district is discussing the idea of enforcing year-round water restrictions, regardless of drought conditions.

The main water supply source for South Florida is Lake Okeechobee, which reached its lowest level on July 2, 2007 (SFWMD Web site, www.sfwmd.gov). The current drought seems to be the most severe, but is certainly not the only drought within the district.

In fact, several regional droughts occurred in recent decades, including 1972-73, 1982-83, 1989-1990, and most recent 1999-2001. In those past droughts, the water management district was able to use the storage capabilities of the Kissimmee chain of lakes, water conservation areas, and Lake Okeechobee to keep a stable water supply, but the current drought affects all three regions of watershed, all reaching historical low water levels.

In the meantime, the water management district passed a Regional Water Availability Rule in February 2007, limiting the shallow Biscayne Aquifer water to current pumpage for water supply utilities. All utilities and other water users have to seek alternatives to meet future demand.

The city of North Miami Beach included an alternative water supply source, the Floridan Aquifer, in the original Norwood-Oeffler Water plant expansion project design. The plant started producing high-quality drinking water from this alternative water source in June 2008, providing a timely relief during drought conditions. Less water will be withdrawn from the Surficial Aquifer, which

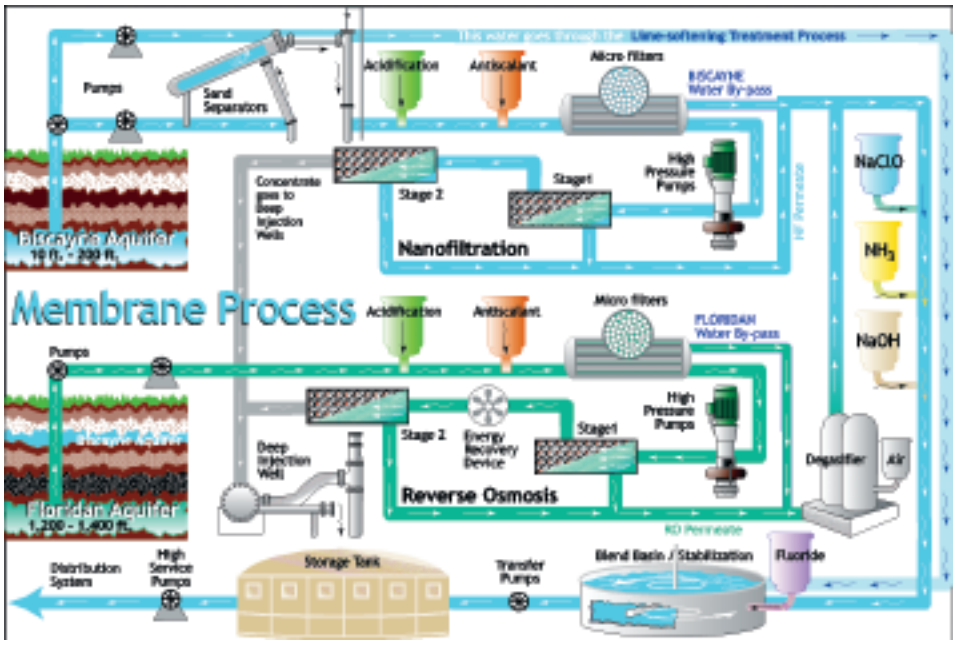

Figure 3: Newly Expanded Norwood WTP Water Treatment Schematic

is significantly affected by the current drought.

Membrane Treatment Process

To provide high-quality water to its customers and to meet potential future regulations, the city of North Miami Beach Utility chose state-of-the-art membrane technology as its water treatment method for the expansion. Because of the two different water sources, the shallow Biscayne Aquifer and the deeper, brackish Floridan Aquifer, separate treatment processes and different membrane technologies had to be utilized. Tables 1 and 2 demonstrate the raw and membrane permeate water quality from both aquifers. Figure 3 shows the schematic of the water treatment process.

One of the most significant expansion challenges facing the operation is that five different water streams are blending before leaving the water treatment plant. The water streams come from the lime softened water; the nanofiltration permeate; the low-pressure, reverse osmosis permeate; the Biscayne raw water bypass; and the Floridan raw water bypass. Because of the Lead and Copper Rule, the finished water quality is required to maintain the water quality before this expansion, in terms of pH, alkalinity, hardness, calcium concentration, etc

Anticipating water chemistry and possibly flow direction changes in the distribution system, North Miami Beach started hydraulic modeling to identify sections that may have possible flow changes. The city then strategically flushed those areas before the new water plant was put into full operation.

Strategic Planning

North Miami Beach started its strategic planning on this treatment plant expansion at a very early stage, which contributed significantly to the success of the expansion.

1) ***Property Acquisition***—The city started to purchase land around the existing water plant immediately after realizing the need to expand the plant, saving millions of dollars by doing so—especially considering that the property values had appreciated more than 10 percent per year since 1997. The Norwood Water Plant is located directly in a residential neighborhood. Some houses were separated from the water plant by only a chain link fence (see Figure 4). About 20 homes rested on approximately seven acres surrounding the plant and were critical to the expansion program. Early planning and vision from city leaders avoided the use of eminent domain, which certainly would have cost more time and money.

Of course, this was not easy by any means, but a team of consultants assessed the financial, environmental, legal, existing homeowner, and community impact. The conclusion was positive, and they developed a plan that would save time and money and lessen media scrutiny.

The city first sent letters to homeowners. These personalized letters explained the need to provide safe, healthy water while preparing for more stringent regulations. The letters went on to explain that in order to achieve these goals, the water utility would need to expand its current facility and would be interested in purchasing their homes.

A number of meetings were held to accommodate homeowners' concerns and to negotiate home prices. The city offered an incentive price of 5 to 7 percent above the appraised value to satisfy homeowners. Even after purchase, the city remained in touch with the homeowners to address some concerns or needs regarding relocation.

Overall, the process was very successful. North Miami Beach was able to acquire critical lands without any delays or problems.

Continued on page 8

Figure 4: Water Plant Surrounded by Residents

Figure 5: Membrane Pilot Unit

Figure 6: Public Relations Video

Continued from page 7

Seeing the benefits, the city continued to acquire land for phase II improvements.

2) ***Feasibility Study***—As early as 1996, the city started to assess the feasibility of water plant expansion. Different processes were studied, including membrane process, enhanced lime softening, and expanding the existing lime softening.

The existing plant was also assessed as to maintaining its operation or replacing it with a new plant. The decision was made to leave the existing lime softening plant in operation and use membrane technology for the expansion to meet future regulations and provide superior quality drinking water.

3) ***Pilot Testing***—In 1998, the city was required by the EPA's Information Collection Rule (ICR) to perform a membrane pilot test program utilizing nanofiltration. The city decided to purchase pilot equipment instead of leasing it. The equipment was a 20-gallons-per-minute membrane pilot system with three stages. This turned out to be another fortuitous decision.

In addition to completing the ICR study successfully, the city obtained valuable data for the design engineer for the full-scale design and created an excellent opportunity to train water plant operators. Through the pilot, five different membrane elements and three chemical pretreatment scenarios were tested with product recoveries ranging from 75 percent to 90 percent. This data proved invaluable for the final design.

Water plant operators performed water quality testing, loaded and unloaded cartridge filters and membrane elements, and adjusted chemicals when necessary. All three operating staff shifts had the opportunity to train on the pilot equipment. The experience will definitely benefit the new membrane plant in operation.

Utilities should consider pilot testing when considering a change in treatment process. Not only will it provide invaluable data for the design, but also will provide an excellent opportunity to train operations staff. The cost of pilot equipment is insignificant compared to the comprehensive cost of a new water plant construction project.

Education Outreach

With the water plant located in a residential neighborhood, North Miami Beach took public relations very seriously. The outreach started even before the authorization for final design, when the city hosted several community meetings to explain its expansion plan and the importance of keeping up with regulations and providing customers with safe, high-quality drinking water.

The city continued to communicate with residents and schools and kept them posted on everything relating to the plant expansion. Customer complaints were very limited during the construction period. Highlights of the public relations campaign included:

(1) ***A Door-to-Door Survey***—Before construction started, city staff members went door to door contacting the immediate neighbors in an effort to explain what was going on with the water plant expansion and what measures would be taken to minimize the impact on the neighborhood. This also provided staff members with the opportunity to hear the residents' concerns. They took this feedback very seriously and made every attempt to accommodate any concerns or requests. At the same time, flyers containing contact information in English, Spanish, and Creole were also sent to all the surrounding neighbors.

(2) ***A Videotape***—Before construction started, the city created public relations videotapes demonstrating the purpose of the construction, duration of the construction, and various activities and actions that would be taken to attenuate the impact on the neighborhood. The videotapes were sent to residents, schools, and businesses.

(3) ***Educational Workshops***—The city staff participated in various community gatherings, homeowners association meetings, and all other opportunities to inform the residents.

(4) ***Communication with Schools***—One of the Norwood plant's neighbors is an elementary school. There are also three other schools near our wellfield. Communications with the schools was very important and was also a helpful tool in getting the information out. The city assigned a specific employee to communicate with schools, spending even more resources to let each school and its students understand what was going on with water plant construction and addressing concerns of school officials.

Design Considerations

One of the design objectives was a neighborhood-friendly facility. With that in mind, specific requirements were added to the design, including:

(1) ***Landscaping***—In addition to covering trees on the perimeter, a linear park was designed around the perimeter of the water treatment facility to create a buffer between the plant and residents.

(2) ***Security***—The new facility is surrounded by a six-foot, precast solid concrete panel screen wall that separates the facility from the community. Lighting around the facility was improved significantly.

(3) ***Noise and Dust Control***—The specifications required construction contractors to have proper noise and dust control measures to keep the impact on residents to minimum.

(4) ***Chlorine Concerns***—The fact that the

Continued on page 10

Figure 7: Linear Park

Figure 8: Concrete Panel Screen Wall

Figure 9: High-Tech Training Facilities

Figure 10: Tour-Friendly Mezzanine Walkway

Continued from page 8

water plant is located in a neighborhood with schools and homes played a significant role in the decision to change from gas chlorine into liquid chlorine for disinfection.

(5) ***Training Facilities***—There was a need for an updated training facility that incorporated the latest technology. The administration building, located next to the membrane process facility, now houses two training rooms complete with computers and a WiFi-enabled campus (Figure 9). The plant is designed to be very tour-friendly. A second-floor mezzanine walkway was enables visitors to overlook both the membrane treatment bay and the existing lime softening treatment system (Figure 10). Because the high-pressure pumps are in a separate room with noise control panels, the noise in the membrane treatment bay is limited, which really helps training onsite or for tours.

Customer Complaints

A procedure to handle customer complaints was established for the entire planning and preparation period. Whoever received the complaint first was required to report it to the utility neighborhood coordinator, the center point of contact, who would immediately contact the customer to identify the nature of the complaint. Then a specific area manager would be contacted and requested to address the complaint immediately. A report to the public services director would follow. Each month, a customer complaints status report was generated to state if and how specific complaints were addressed.

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