

**Client**  
City of Pompano Beach

**Scope of Services**  
Membrane pilot testing, permitting, preparation of contract documents for direct procurement of membranes as well as membrane element loading, bidding, contract administration, on-site observation during loading, and review of membrane performance testing.

**Contact**  
Mr. Phil Hyer  
Utilities Treatment Plants  
Superintendent  
City of Pompano Beach  
1205 N.E. 5<sup>th</sup> Avenue  
Pompano Beach, FL 33061  
954.545.7030  
Phil.hyer@copbfl.com

**Start Date**  
03/2016

**Completion Date**  
05/2020

**Initial Construction Cost**  
\$1.098 million

**Change Orders & Cost**  
None

**Final Construction Cost**  
\$1.098 million

**Key MBC Staff**  
Frank A. Brinson, P.E.  
Andrew Barba, E.I.

**Key Features**

- Reduced feed pressure and elimination of pretreatment chemicals resulted in an annual operating cost savings of ~\$352,000.

## Nanofiltration Membrane Element Pilot Testing and Replacement

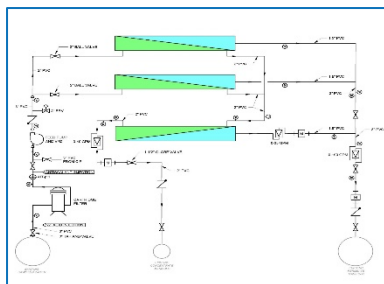
Pompano Beach, Florida



### Background

The City of Pompano Beach owns and operates a 50 million gallon per day (mgd) capacity Water Treatment Plant (WTP) which consists of a 10 mgd capacity nanofiltration (NF) process in parallel with a 40 mgd conventional lime softening process. The NF process includes five 2 mgd NF units arranged in a two-stage, 36:16 array, and the system was designed to operate at an 85% recovery rate with an average flux of 13.7 gallons per square foot per day (gfd). The NF units were populated with a hybrid of 1,820 membrane element models (Hydranautics ESNA1-LF and ESNA1-LF2), which were installed in 2009. NF membrane elements typically have a useful service life of 5 to 7 years. In 2016, The City was ready to begin replacing the existing NF membrane elements.

Under this project the City was interested in investigating the possibility of reducing operating costs by completely eliminating chemical pretreatment (sulfuric acid and antiscalant) of the feedwater, and by taking advantage of advances in membrane technology to reduce power costs and eliminate chemical pretreatment of feedwater. In pursuit of this goal, the project included extensive membrane process pilot testing.



In preparation for the membrane element replacement, the City and MBC designed, permitted, and constructed a pilot unit that utilized full-size (8-inch diameter, 7-element) pressure vessels in a 2:1 array with independent cartridge filters and pre-treatment chemical feed systems. The pilot unit was permitted to withdraw feedwater from the NF process raw water header and discharge permeate and concentrate to the plant's respective headers.



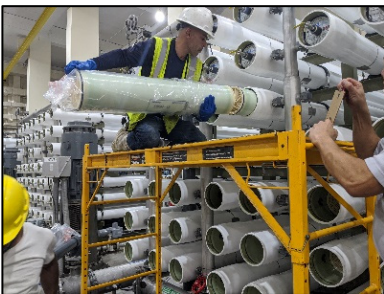
Pilot testing was conducted in two phases. Phase 1 (for each membrane element manufacturer) consisted of prequalification testing for potential bidders, aimed at confirming that the City could meet the specified permeate quality and membrane performance requirements with the replacement membrane elements under the current operating conditions of full-scale NF process (acid and antiscalant chemical pretreatment, 85% recovery rate, and 13.7 gfd average flux). Phase 2 testing was conducted to evaluate the performance of the membrane selection and potential fouling tendencies under modified operating conditions (no chemical pretreatment, an 82% recovery rate, and a 12.2 gfd average flux).

The City requested letters of interest (LOI) from three leading nanofiltration membrane element manufacturers (MEM); Hydranautics, Dow Water and Process Solutions, Inc. (Dow), and Koch Membrane Systems, Inc. The City received responses from Hydranautics and Dow.



These LOI's requested membrane selections from the MEM's, in preparation for prequalification pilot testing, to verify that the membrane selections meet the City's specified permeate quality and membrane performance requirements. Meeting these permeate quality and membrane performance requirements during pilot testing allowed the MEM's proposed membrane element selections to prequalify for installation in the City's full-scale NF process skids under the Nanofiltration Membrane Element Replacement Project.

The membrane elements provided by both MEM's met the specified permeate quality and membrane performance requirements under Phase 1 and 2 operating conditions which prequalified the proposed membrane element selections for installation in the City's full-scale NF process skids. Furthermore, pilot testing of the Hydranautics membranes demonstrated stable operation with no chemical pretreatment. In May 2019 the City advertised bid documents for the Nanofiltration Membrane Element Replacement Project and following evaluation of bid packages, Hydranautics was identified as the low bidder and the City issued a notice to proceed in December 2019.



The initial new membrane element loading configuration used on the full-sized was consistent with the pilot unit (first-stage: 7 ESPA 4-LD elements, second-stage: 7 ESNA-LF2-LD elements). However, when the first unit was started-up, it was found that this loading configuration did not meet the specified permeate quality requirements. Hydranautics elected to modify the loading configuration, as allowed in the contract.

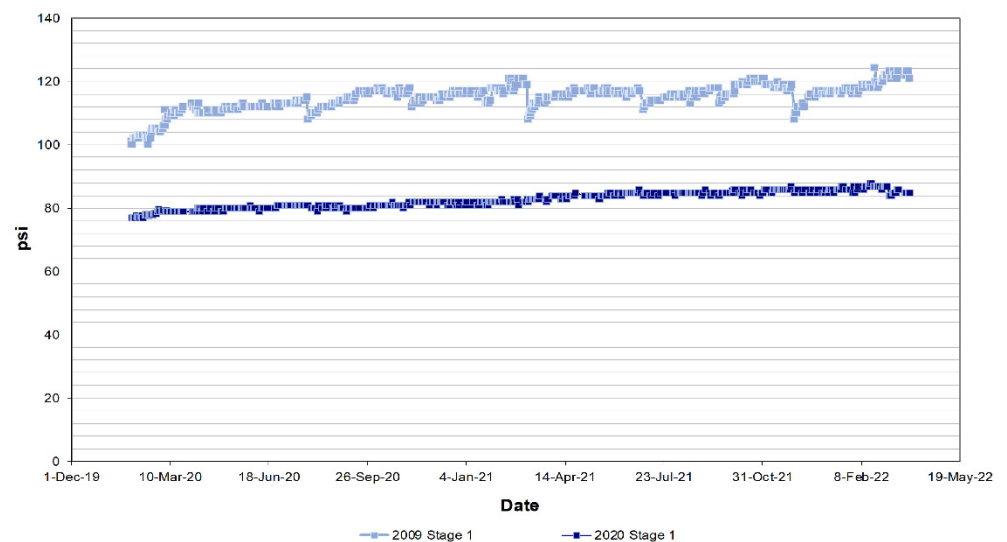
This modified loading configuration allowed the full-scale NF process to meet specified performance and permeate quality requirements, with no chemical pretreatment. The project was completed in May 2020, six months ahead of schedule. At start-up, the average feed pressure of the NF process skids was 73 psi with the new membrane elements, approximately 17 psi lower than the start-up pressure of the City’s previous membrane elements. As of April 2022, the plant has been operating for two years with no chemical pretreatment, meeting all water quality goals. The City has performed one routine cleaning in that two-year period. The elimination of chemical pretreatment, coupled with the reduction in feed pressure, resulted in a total annual operating cost savings of approximately \$352,000.

## The Project

MBC’s scope of services for the project included the following:

- Design of a 2:1 array full-size element (8-inch diameter, 7-element) pilot plant.
- Development of technical specifications for the replacement membrane elements and membrane performance requirements, and negotiations with the membrane element manufacturer for direct purchase of the elements.
- Development of technical specifications and bidding documents for a separate membrane loading contract by a qualified membrane systems contractor.
- Permitting and bidding services.
- Contract administration during the loading period.
- On-site observation of membrane loading.
- Review and approval of membrane performance acceptance testing.

This project reached final completion in May 2020, six months ahead of schedule, with no change orders.



**Comparison of Start-Up Feed Pressure: 2009 vs. 2020**