ICR Treatment Study Summary Report

Evaluation of Membrane Technology

Conducted during the period of April 06, 1998 through March 20, 1999

Collier County Public Works Water Department
3301 East Tamiami Trail, Building H
Naples, FL 34112

FL5114069

North Collier Regional Water Treatment Plant, ICR # 1092

Water Quality Parameter	units	Average Yearly Concentration	Standard Deviation	Maximum Yearly Value	Minimum Yearly Value
pH	---	7.17	0.09	7.27	7.01
Temperature	^{o}C	25	0.5	25.7	24.2
Alkalinity	mg/L as $CaCO_3$	290	8.6	300	276
Total dissolved solids	mg/L	453	18	494	432
Total hardness	mg/L as $CaCO_3$	303	4.6	310	294
Calcium hardness	mg/L as $CaCO_3$	236	12.7	254	216
Turbidity	ntu	0.23	0.03	0.31	0.2
Ammonia	mg NH_3-N / L	0.3	0.08	0.5	0.2
Total organic carbon	mg/L	8.3	0.5	9	8
UV_{254}	cm^{-1}	0.24	0.021	0.276	0.22
SUVA	L/(mg*m)	2.9	0.11	3.07	2.78

Summary of Source Water Quality

Water Quality Parameter	units	Average Yearly Concentration	Standard Deviation	Maximum Yearly Value	Minimum Yearly Value
pH	---	8.53	0.19	8.86	8.30
Temperature	^{o}C	25.2	0.63	26.0	24.1
Total organic carbon	mg/L	0.2	0.5	2.0	BMRL
Distribution System THM4	*u*g/L	13.2	3.9	20.0	8.0

Summary of Finished Water Quality

- Finished water from two separate water plants is blended into one system. Lime softening and membrane filtration treatment processes are utilized and there is a noticeable difference in water quality at the far ends of the system in relation to the location of the plants. For distribution THMs I took data from the sites associated with membrane softening treatment.

Analyte	Method	Minimum Reporting Level
Alkalinity	SM 2320 B	0.1 mg/L
Ammonia	SM 4500 NH_3 F	0.10 mg/L
Bromide	EPA 300.0	0.020 mg/L
Calcium Hardness	SM 3500 Ca D	0.1 mg/L
Chlorine Residual	EPA 330.4	0.1 mg/L
BCAA, BDCAA, DBAA, DCAA, MBAA, TCAA	SM 6251 B	1.0 *u*g/L
DBCAA, MCAA	SM 6251 B	2.0 *u*g/L
TBAA	SM 6251 B	4.0 *u*g/L
pH	EPA 150.1	Not Applicable
TDS	SM 2540 C	1 mg/L
Temperature	EPA 170.1	0.1 ^{0}C
CHCl3, BDCM, DBCM, CHBr3	EPA 524.2	0.5 *u*g/L for each analyte
Total Hardness	SM 2340 C	0.1 mg/L
TOC	EPA 415.1	1 mg/L
TOX	SM 5320	25 *u*g/L
Turbidity	SM 2130 B	0.01 ntu
UV_{254}	SM 5910 B	1/cm

Summary of Analytical Methods and MRLs Used During Study

Laboratory	Dates of Service	Analyses Performed
CCPWWD Laboratory	04-06-1998 – 03-20-1999	Alkalinity, Ammonia, Calcium Hardness, Chlorine residual, pH, TDS, Temperature, Total Hardness, Turbidity, UV_{254}
Montgomery	04-06-1998 – 03-20-1999	HAA9, Bromide, TOX
PBS&J	04-06-1998 – 03-20-1999	THM4, TOC

Summary of Laboratories Conducting Analyses During Study

Unit Process	Process Description
Raw Water Static Mix	Type of Mixer: In-Line Static Mixer Baffling Type: Baffled Liquid Volume (gal): @ 100 Acid Addition: Sulfuric Acid 93% Acid Dosage (mg/L): @ 150 (to pH of 6.0) Scale Inhibitor Addition: Aquafeed 600 (BF Goodrich) Scale Inhibitor Dosage (mg/L): @ 1.43
Cartridge Filtration	Surface Area (sf): 2.14 per cartridge Total Surface Area (sf): 2.14 x 231 cart. x 5 housings = 2,472 Nominal Pore Size (micron): 5 Filter Material: Polypropylene Filter Life (million gallons): 1.26 (@ 6 month life)
Membrane Softening	Type of Membranes: Hydranautics PVD1 (8540-LSY-PVD1) Treatment Stages: 3 Membrane Pressure Vessel Array: 36:18:7 Membrane Elements Per Vessel: 6 Total Membrane Elements: 366 Membrane Element Size: 8” diameter X 40 “ length Membrane Element Surface Area 365 sf First Stage Feed: 1,572 gpm First Stage Permeate: 925 gpm First Stage Permeate Per Element: 4.28 gpm Second Stage Feed: 617 gpm Second & Third Stage Permeate: 464 gpm Second & Third Stage Permeate Per Element: 3.09 gpm Total Permeate: 1,389 gpm Total Concentrate: 153 gpm
Degasifiers	Type of Degasifiers: Forced Draft Air Flow Rate: 10,000 cfm Media/Packing Type: Polyethylene, Jaeger Tri-Pak, 2” diameter Packing Volume Per Digasifier Unit: 1,520 cf
Clear Well	Surface Area (sf): @ 2,130 Liquid Volume (gal): @ 119,500 Baffling Type: No Baffling Covered Contacting: Yes
Disinfection	Chemical Type: Chlorine & Ammonia Gases (Chlorimination) Chlorine Dose (mg/L): 8.0 Ammonia Dose (mg/L): 1.3 Finished Combined Chlorine Residual (mg/L): 4.5
Finished Water Static Mixer	Type of Mixer: In-line Static Mixer Baffling Type: Baffled Liquid Volume (gal): @ 100 Corrosion Control Chemical: Ortho/Polyphosphate Corrosion Inhibitor Dosage (mg/L): 1.05 Fluoridation Chemical: Sodium Silico Fluoride Fluoride Dosage (mg/L): 0.7 Finished Fluoride Level (mg/L): 1.0 Caustic Soda (50%) Dosage (mg/L): @ 9.0 to pH of 8.3
Ground Storage	Storage Type: Above Ground Storage Tank Storage Capacity (MG): 6

Summary of Treatment Plant Design Data

The full-scale treatment Study of the Collier County North Regional Water Plant, a three stage membrane softening process will be conducted as follows:

The treatment study will be conducted on a single skid. The run-time will be a minimum of 6600 hours or approximately 75% of the calendar year. The minimum system recovery will be at least 75% while meeting membrane manufacturer's specifications. The flow diagram of the three stage system uses a numbering system to identify the monitoring locations, equipment, and chemicals used in the treatment process. The numerical identification code table presents a description on these sampling sites. The specific membrane characteristics and treatment data is listed in the Membrane Characteristics and the Membrane Pretreatment Data tables.

Samples will be collected from the monitoring locations on the numerical code table. The sampling interval and location for each test parameter is outlined in the Monitoring Matrix Table. The operations staff will conduct daily monitoring. Feed Water pH and TDS readings will be performed by the operations staff once per week. Parameter values from past monitoring of these parameters maintain consistent levels. Therefore, feed water monitoring of pH and TDS has been reduced from daily to once per week. Daily monitoring will be recorded on daily operation log sheets and summary reports will be submitted for each stage and the system using the ICR Treatment Studies Manual Table 6-11 format. Collier County Water Department Laboratory personnel will collect biweekly monitoring samples. Biweekly sample analysis will be performed according to ICR methodology. Samples for TOC, Bromide, THM4, HAA6, and TOX analysis will be forwarded to a Certified Contract Laboratory for analysis. SDS samples will be prepared by Collier County Lab Staff before shipping to the contract lab. The distribution system equivalent (DSE) detention time has been estimated by the engineering staff as 40-48 hours. This DSE time will be used as the storage interval in simulated distribution system (SDS) analyses.

A brief description of the standard membrane cleaning procedure has been included in this sampling plan. Membrane cleaning conducted during the treatment study will be performed according to this protocol. Operations staff will reference this cleaning protocol in the ICR reports along with the dates, times, type of cleaning chemicals, and dosages used. Any changes in the membrane cleaning protocol will be documented in the ICR reports.

The following additional information will be added to ICR reports when appropriate: changes in the system operating parameters; all system shut-downs which exceed two hours; process upsets that affect performance, water quality changes, and element replacements.

During the initial start-up phase of the membrane softening plant, large quantities of sand in the feed water caused significant performance problems. All groundwater production wells and several key locations along the raw water transmission lines were tested to determine the source of the sand. Test results indicated that sand was introduced in to the raw water system during construction of the raw water transmission mains. Annual pigging of the raw water system has kept the transmission mains free of debris. No further sand related performance problems have been experienced since the initial start-up phase.

Collier County North Regional Water Plant
Membrane Operations Cleaning Protocol

The following steps in the cleaning process allow for continued and proper operation of the membrane treatment plant. Cleaning is scheduled based on stage differential pressures.

1. To clean and individual train, close the permeate valve and drain the skid to be cleaned.
2. Remove 6" victaulic on the front of the skid on stage one.
3. Install cleaning piping per diagrams.
4. Fill cleaning tank with 2500 gal of permeate and select the proper cleaning chemical and dosage rate. Add cleaning chemical in a safe manner. Please read and follow all safety procedures per MSDS. All appropriate safety equipment must be used.
5. Place valve on the cleaning system to the proper positions. Fill skid slowly before starting the cleaning pump.
6. Start the cleaning pump, being careful not to exceed 60 psi discharge pressure.
7. Recirculate for the desired time and dump and refill with fresh solution. Secure the pump and close all valves, let soak for the desired time.
8. Drain cleaning solution and flush with permeate water. Reinstall piping and start skid.
9. To clean stage two and three, close the permeate valve. Drain the skid to be cleaned and remove 6" ss tee at the rear of the skid.
10. Repeat steps 3-8.

Skid cleaning monitoring parameters:

Discharge pump pressure - 60 psi
2^{nd} stage feed pressure - 44 psi
3^{rd} stage feed pressure - 32 psi
D.P. stage 3 - 12 Δpsi

Simulated Distribution System Test Procedure

Feed water and Effluent samples for SDS testing will be collected from sampling locations 4 and 11 respectively. Sample volumes will large enough to generate all required SDS testing. Samples will be collected in clean glass containers with Teflon lined caps. The approximate SDS chlorine demand will be determined prior to the ICR treatment study using representative feed water and effluent samples. The source water used in the treatment process has consistent water quality. Therefore, preliminary chlorine demand values can be reasonably determined. Feed and effluent water samples will be chlorinated using bleach to produce a free residual at the end of incubation of 0.5 to 1.0 mg/L. The samples will then be adjusted to the average pH of the distribution system (8.4units) using sodium hydroxide. Placing the samples in a bath of continuously running finished water for the average residence time of the distribution system will incubate the samples. The SDS incubation time was estimated by the engineering staff as 40-48 hours. The intermediate interval of 44hous +/- 5% will be used as the incubation interval. The following information will be recorded for the SDS preparation process:

Sample pH prior to adjustment
Chlorine dosing solution concentration
Chlorination Dosage
Sample pH after pH adjustment
Sample Temperature
Water Bath Temperature beginning/end incubation
Sample pH and Chlorine Residual after incubation

At the end of incubation, the SDS aliquots will be immediately sampled for SDS THM4, HAA6, and TOX. Sample containers for this analysis will be obtained from a contract Laboratory prior to incubation. The SDS analysis will be shipped to the contract laboratory for analysis immediately after collection. The SDS chlorine demand will be determined from the dosing concentration and the chlorine residual after incubation.