Bryan W. Shaw, Ph.D., P.E., *Chairman*
Toby Baker, *Commissioner*
Richard A. Hyde, P.E., *Executive Director*

PWS_2430001_CO_20150717_Exception

Texas Commission on Environmental Quality

Protecting Texas by Reducing and Preventing Pollution

July 17, 2015

Mr. Shawn M. Garcia, P.E.
City of Wichita Falls
1300 7th Street
Wichita Falls, TX 76307

Subject: Request for an Exception to Use HF/RO Membranes
City of Wichita Falls - Public Water System ID No. 2430001
TCEQ Plant ID No.21567 Cypress 2008 RO Membrane Plant
Wichita County, Texas

CN600129316: RN105598759

Dear Mr. Garcia:

On June 3, 2015, the Texas Commission on Environmental Quality (TCEQ) received your letter dated May 29, 2015, for the decommissioning of the Temporary Direct Potable Reuse (DPR) water treatment plant (WTP). You letter also requested aprpoval for reconfiguring the Cypress 2008 Reverse Osmosis (RO) Membrane Plant (TCEQ ID 21567) to treat raw Lake Kemp water as it did before the configuration as the Temporary DPR WTP. TCEQ had previously reviewed and approved the hollow-fiber (HF) microfiltration (MF) and RO membranes for the surface water treatment plant (SWTP). As stated in our rules and regulations, the use of HF MF and RO membranes is considered innovative technology under Title 30 of the Texas Administrative Code (30 TAC) §290.42(g). The TCEQ rules require staff to review the proposed use of the HF MF and RO membranes for the production of potable water as an exception under 30 TAC §290.39(l).

The information provided below is for the Cypress 2008 RO Membrane Plant (TCEQ ID 21567) treating water from Lake Kemp. This letter completely replaces TCEQ's previous HF/RO approval letters for this treatment plant.

MF MEMBRANES FOR PATHOGEN REMOVAL

Each membrane facility providing treatment for pathogen removal credit must receive the following TCEQ approvals prior to the production of drinking water. This letter addresses each item individually.

1. Approval of the exception to use the membranes;
2. Approval of direct integrity test (DIT) and LRV_{DIT} calculation methods; and
3. Approval of a challenge study if membranes are installed or replaced after April 1, 2012.

Based on our review, we are **granting** an exception for the use of Evoqua (formerly Siemens Memcor distributed by USFilter) S10V MF membrane modules in lieu of granular media filters under the operating parameters and conditions listed on the following pages.

I EVOQUA S10V MF MEMBRANE MODULES CAPACITY – WITH SEDIMENTATION

The TCEQ finds that the proposed operating parameters are acceptable to yield 4,277 gallons per day (GPD) of net filtrate water available for use by the City's customers at an instantaneous flux rate of 19.6 gallons per square-foot per day (gfd) at a temperature of 20° C, for a 300-sf membrane element with the following characteristics and under the following conditions:

- A conventional pretreatment train consisting of a raw water reservoir, flocculation, coagulation and clarification;
- An MF pressure driven membrane element with a total feed-side surface area of 300 square-feet (sf) per membrane fiber bundle;
- A nominal pore size of 0.2-micron;
- Maximum transmembrane pressure (TMP) of -12 pounds per square-inch (psi);
- Water temperature range of 1o to 40°C;
- pH tolerance range of 2 to 12;
- Five tanks containing 504 submerged MF membrane elements per tank;
- A maximum instantaneous flux rate of 19.6 gallons per square-foot per day (gfd) at 20 °C;
- Typically a three-minute backwash duration (nine minutes out of service) once every 30 minutes of run-time;
- Typically a 32-minute maintenance clean (45 minutes out of service) once per 24 hours of run-time; and
- A CIP procedure once every 720 hours of run-time;
- A total of approximately 1,071 minutes per day in filtrate mode and 369 minutes per day in backwash and maintenance clean activities; and
- A gross filtrate production of 4,375 GPD per module and an in-plant use of filtrate of 98 GPD to yield a net filtrate of 4,277 GPD per 300-sf module at 20° C available for customer use.

Based on the new module's surface area and the previously approved flux rate, the TCEQ would calculate a capacity of 10.8 MGD for the HF MF membrane portion of the SWTP design using 504 Evoqua S10V MF membrane modules per train and 5 trains.

The TCEQ issues a net capacity rating for MF membrane facilities based on an instantaneous filtrate flux corrected to 20° C. This rating is determined by subtracting the total in-plant use of produced filtrate (such as backwashing the membranes, any "maintenance cleans", EFM, "mini CIP", CEB, soaks, or any other in-plant use) from the gross potential filtrate production when a membrane unit is actually in service for a 24-hour period of operation. The TCEQ understands that an increase in membrane feed water temperature normally results in an increase in the filtrate flux rate and a corresponding increase in potable water available for customer use. A decrease in water temperature will result in a reduction of the filtrate flux rate and a corresponding decrease in potable water available for customer use. This seasonal increase and decrease of water temperatures correspond to the accepted increase of summer and decrease of winter customer demands.

This increased production shall have TCEQ approval provided it does not exceed a temperature corrected filtrate flux rate based on the following calculation:

$$\text{filtrate flux}_{\text{at feed water temperature}} = \frac{(\text{filtrate flux}_{\text{at 20 C}})}{[1.784-(0.0757 * T)+(0.0011 * T^2)-(10^{-5} * T^3)]}$$

Where T is the MF membranes' feed water temperature in degrees centigrade (^oC), and filtrate flux at 20°C is 19.6 gfd.

II EVOQUA S10V DIT RESOLUTION AND LRV_{DIT} SENSITIVITY CALCULATIONS

To comply with TCEQ rules and federal requirements, water treatment plants that use membranes for pathogen removal credit must submit a Surface Water Monthly Operating Report for Plants using Alternative Technologies (SWMOR-Alt) each month. This form, TCEQ Form 0102D, is an Excel® spreadsheet that must be customized based on site-specific design and operational conditions. When they create the customized SWMOR-Alt for WTP, the operators will need to enter the approved DIT parameters. The spreadsheet will use this information to compare the actual test conditions with the approved conditions and determine if the membrane units are continuing to meet minimum performance requirements.

To help the operators customize their SWMOR-Alt, we have prepared Table 1 which shows the approved minimum initial test pressure (P_{test}, or $P_{initial}$); the Upper Control Limit (UCL), which is the maximum allowable pressure decay rate allowed during a DIT; and the Log Removal Credit (LRC) that TCEQ has approved for the membrane units at the plant. The DIT parameters for the Cypress 2008 RO Membrane Plant (No. 21567) using Evoqua (formerly Siemens Memcor distributed by USFilter) S10V MF membrane are as follows.

TABLE 1: DIT PARAMETERS FOR THE CYPRESS 2008 RO MEMBRANE PLANT (No. 21567)

Initial Test Pressure (P_{test}) (psi)	Log Removal Credit (LRC) (log)	Upper Control Limit (UCL) (psi/min)
16.5	3.0	0.98

(1) Based on the data and calculations shown in Attachments 1.

Please note that the DIT must be performed for a time period where the UCL (0.98 psi/min) can be detected. For example, with a P_{test} of 16.5 psi and UCL of 0.98 psi/min the test must be conducted for **less than 16.8 minutes** to be able to detect 0.98 psi/min pressure decay. This is because all pressure could be lost at 16.83 minutes if the decay rate was at the UCL. Therefore, for any test duration greater than 16.8 minutes where all pressure is lost, the calculated rate of pressure decay would be incorrect (it would show compliance with the UCL when a failure had actually occurred).

Based on the plant's special source water monitoring results, the Cypress 2008 RO Membrane Plant (No. 21567) has been classified as a Bin 1 facility. For a water system classified as a Bin 1 facility, the operators must conduct a DIT on each membrane unit, or rack, at least once every seven (7) days that the unit treats any water.

III CHALLENGE STUDY

In accordance with 30 TAC §290.42(g)(3), for membrane systems used for microbiological treatment, the level of removal credit granted for *Cryptosporidium* and *Giardia* shall not exceed the lower of:

- the removal efficiency demonstrated during challenge testing conducted under the conditions specified in Title 40 of the Code of Federal Regulations §141.719(b)(2), or

- the maximum removal efficiency that can be verified through direct integrity testing used with the membrane filtration process under the conditions specified in 30 TAC §290.42(g)(3)(B).

Because the source water is Bin 1 source water and the membranes were installed before April 1, 2012, the 3.0-log removal credit for *Cryptosporidium* and *Giardia* is now based on the direct integrity test parameters approved in this letter. The previously granted 2.8-log credit only applied to the temporary direct potable reuse water treatment plant which included the use of the Cypress 2008 RO Membrane Plant MF membranes.

IV CONDITIONS OF APPROVED EXCEPTION FOR THE USE OF MF MEMBRANES

1. To comply with TCEQ rules and federal requirements, water treatment plants that use membranes for pathogen removal credit must conduct periodic DITs to verify the removal efficiency of the membrane treatment process. These plants must also submit a monthly operating report designed specifically for plants that use alternative technologies such as membrane filters. This form, TCEQ -00102D, is called the Surface Water Monthly Operating Report SWMOR-ALT version 15 for plants using membrane treatment. The spreadsheet has been released and is available at:

   http://www.tceq.texas.gov/drinkingwater/swmor/swmor/swmor-forms-and-instructions#form-alt.

2. Approval from the TCEQ will be necessary prior to the use of any raw water source(s) other than Lake Kemp. If the City desires to use water from a source other than Lake Kemp, an additional pilot study needs to be initiated using water from the alternate source(s).

3. Indirect integrity monitoring of each unit's filtrate turbidity levels must be continuously monitored and recorded at least once every five minutes using the HACH FilterTrak Method No. 10133, approved by the U.S. Environment Protection Agency. Please contact TCEQ if particle counters or monitors will be used instead of turbidimeters.

4. As stated in 290.42(g)(3)(F), membrane systems must be designed so that membrane units' feed water, filtrate, backwash supply, waste and chemical cleaning piping shall have cross-connection protection to prevent chemicals form all chemical cleaning processes from contaminating other membrane units in other models of operations. This may be accomplished by the installation of a three-valve block and bleed arrangement, a removable spool system or other alternative methods approved by the executive director.

5. A direct integrity test (DIT) must be conducted:

   a) Once every 7-days based on the Bin 1 classification for this plant, as determined by the results of the source water monitoring for *Cryptosporidium*, and as required by 30 TAC §290.111(f)(2)(D)(iii);

b) After every CIP procedure;
c) On any membrane unit that produces water with a turbidity level above 0.15 NTU on two consecutive readings as required by 30 TAC §290.111(f)(2)(D)(v); and
d) In accordance with the requirements in 30 TAC §290.42(g)(3)(B).

6. Membrane units that fail a DIT cannot produce water until the defective unit is inspected and repaired, and then subsequently passes the DIT as required in 30 TAC §290.111(f)(2)(D)(vi).

7. Pressure monitors used for DIT measurements shall be calibrated or verified at least once every 12 months.

8. Combined filter effluent and individual filter effluent must be monitored in accordance with 30 TAC §290.111(f)(2).

9. A turbidity level exceeding 1.0 NTU in the combined filter effluent of membrane filters will result in an acute treatment technique violation as specified in 30 TAC §290.111(i)(4).

10. In accordance with 30 TAC §290.42(j), all treatment chemicals and media used in the full-scale facility must conform to American National Standards Institute/National Sanitation Foundation (ANSI/NSF) Standard 60 for direct additives and ANSI/NSF Standard 61 for indirect additives and must be certified by an organization accredited by ANSI. This includes coagulants, disinfectants, acids, caustics, citric acid, and other membrane cleaning chemicals.

11. As required by 30 TAC §290.46(e)(6), the membrane filtration facilities must be operated and maintained at all times under the direct supervision of an operator with a Class "C" or higher surface water license. The qualified operator must be present anytime:
    a) The membrane elements are replaced and/or repairs are made to the membrane unit;
    b) A CIP is performed;
    c) A direct integrity test is performed;
    d) Changes are made to the treatment process; or,
    e) The membrane units' operating parameters are changed.

12. A qualified operator must be present at the membrane facility whenever water is being treated unless the membrane plant is provided with continuous monitors, alarms, and shutdowns. Specifically, the water system must provide:

    a) An alarm system maintained to summon the operators in the event of an apparent degradation in filtrate quality. The alarm must summon the operators if an individual turbidimeter has two consecutive readings above 100 mNTU (0.10 NTU).
    b) Controls to automatically take a membrane rack out of service if the turbidity level for the rack rises above 0.15 NTU for two consecutive readings.

RO MEMBRANE USE FOR CHEMICAL REMOVAL

The RO system is comprised of 6 units with a two-stage single-pass RO process. Currently, the plant uses 40-inch (in length) Hydranautics RO elements with an **average unit flux rate of 14.9 gallons** per square-foot per day (gfd). Based on our review, we are **granting** an exception for the use of the RO membrane modules under the operating parameters and conditions listed on the following pages.

1) All media including RO elements, and cartridge filters must be American National Standards Institute/NSF International (ANSI/NSF) Standard 61 certified.

2) The RO elements must be operated within the allowable operating parameters defined by the manufacturer.

3) The RO elements must be cleaned or replaced when fouling causes either: a) loss of water output, b) operation of equipment outside the allowable limits of the manufacturer, or c) failure to meet the State's water quality standards.

   The membrane system shall be cleaned, or replaced, in accordance with the allowable operating conditions of the manufacturer and shall be based on one or more of the following: increased salt passage, increased or decreased pressure differential, and/or change in normalized permeate flow.

4) The system will provide an onsite cleaning system where the elements can be removed and cleaned as needed. The system must maintain records of each cleaning process including the date, duration, and procedure used for each event for two years.

5) The RO filtration facilities must be operated and maintained at all times under the direct supervision of an operator with a Class "C", or higher, license as required by TCEQ rules. The qualified operator must be present anytime:

   a) the RO elements are replaced and/or any repairs are made to the RO unit;
   b) anytime changes are made to the treatment process; and,
   c) anytime the RO units' operating parameters are changed.

   Please be aware that TCEQ's Commissioners approved a rule package on July 1, 2015 that includes the requirement for PWS that use RO to have an operator that has successfully completed at least one executive director-approved training course or event specific to the operations and maintenance of revise osmosis or nanofiltration membrane treatment by September 1, 2016.

6) The water system must ensure that the operator has been trained regarding the use of all chemicals at the facility (see 30 TAC §290.46(e)(2)(B)). The training programs must meet applicable standards established by the Occupational Safety and Health Administration or the Texas Hazard Communication Act, Texas Health and Safety Code, Title 6, Chapter 502.

7) All treatment chemicals and media, including cartridge filters, used in the full-scale facility must conform to ANSI/NSF Standard 60 for Drinking Water Treatment Chemicals or ANSI/NSF Standard 61 for Drinking Water System Components and be certified by an organization accredited by ANSI (30 TAC §290.42(j)).

8) Chemical storage and chemical feed facility must meet the standards in 290.42(f)(1) and (2).

9) The RO membrane system must be designed so that feed water, cleaning chemicals, RO concentrate, and RO permeate are protected from cross-connections during other modes of operation.

10) The pipes and pipe galleries shall meet the minimum requirements specified in 290.42(d)(12) and (13).

11) The RO membrane system shall be equipped to measure conductivity or total dissolved solids in the feed and permeate water.

12) The water system must provide pressure measuring and recording devices before and after each membrane stage.

13) Flow meters on the feed, permeate, and concentrate water must be provided. Metering devices shall be located to facilitate use and to assist in the determination of chemical dosages, the accumulation of water production data, and the operation of plant facilities.

14) The water system must provide equipment to monitor the temperature of the water. The temperature of the water must be measured using a thermometer or thermocouple with a minimum accuracy of plus or minus 0.5 degrees Celsius.

15) The system must monitor the conductivity (or total dissolved solids) of the feed and permeate water once per day.

16) The system must record the amount of water treated each week.

17) Conductivity (or total dissolved solids) monitors and pressure instruments used for reverse osmosis membrane systems shall be calibrated at least once every 12 months.

18) Flow measuring devices and rate-of-flow controllers that are required by this exception shall be calibrated at least once every 12 months.

19) Any temperature monitoring devices used for reverse osmosis shall be verified and calibrated in accordance with the manufacturer's specifications.

20) A plant operations manual is required by 290.42(l). In addition to the items listed, the manual must also include the system's configuration, baseline performance data, and any set point for membrane cleaning or replacement.

21) Treatment effectiveness monitoring records must be kept for 3 years. Treatment effectiveness monitoring includes the parameters for determining when maintenance is required. Examples of parameters to be monitored include conductivity (or total dissolved solids), transmembrane pressure differential, flow, flux, and water temperature.

22) The production capacity of a reverse osmosis or nanofiltration membrane system shall be the quantity of permeate water after post-treatment that can be delivered to the distribution system. The amount available for customer use must consider:

    a) the quantity of feed water discharged to waste;
    b) the quantity of bypass water used for blending;
    c) the quantity of permeate water used for cleaning and maintenance; and
    d) any other loss of raw water or groundwater available for use due to other processes at the reverse osmosis or nanofiltration facility.

23) All waste discharge must be in accordance with federal and state requirements as described in 30 TAC §290.42(i). Your submittal states that you will use evaporation lagoons with periodic withdrawal and disposal by a contractor.

All exceptions are subject to periodic review and may be revoked or amended if warranted. All conditions contained in this letter for granted exceptions are site specific design, operation, maintenance, and reporting requirements for the City's membrane filtration SWTP as specified in 30 TAC §290.39(l)(4). Failure by the City to comply with these conditions will result in the City being in noncompliance with TCEQ's minimum requirements.

Also, if the TCEQ Regional staff determines during their on-site inspections that the membranes are causing degradation of the finished water quality or the plant's ability to meet the customers' quantity demands, the applicable exception, or exceptions, will be revoked or revised.

If you have any questions concerning our evaluation of the exception request, or if we may be of further assistance, please contact me at the letterhead address, by email at marlo.berg@tceq.texas.gov or by phone at (512) 239-6967.

Sincerely,

Joel Klumpp, Manager
Plan and Technical Review Section
Water Supply Division
Texas Commission on Environmental Quality

JPK/mew

Enclosures: Attachment 1: Direct Integrity Test Parameter Calculations

cc: City of Wichita Falls, Attn: Honorable Glenn Barham, P.O. Box, 1431 Wichita Falls, TX 76307-1431
City of Wichita Falls, Attn: Mr. Darron Leiker, City Manager, 1300 7th Street, Wichita Falls, TX 76301
City of Wichita Falls, Attn: Daniel K. Nix, Utilities Operations Manager, P.O. Box 1431, Wichita Falls, Texas 76307-1431
Mr. Mark Southard, Water Superintendent, City of Wichita Falls, P.O. Box 1431, Wichita Falls, TX 76307-1431

bcc: TCEQ Abilene Region - R3
TCEQ Tracer Study File
Mr. Donald Hunter, TCEQ DWQT, MC 155

Attachment 1: Direct Integrity Test Parameter Calculations

City Of Wichita Falls
Cypress 2008 RO Membrane Plant

Direct Integrity Test (DIT) Resolution and Sensitivity Calculations:
Title 30 of Texas Administrative Code (TAC) §290.42(G)(3)(B) was amended in January 2008 to require removal credit awarded to a membrane filtration system to be based on the lower of either the log removal value (LRV) proven by a direct integrity test (LRV_{DIT}) or the log removal value proven by a challenge study ($LRV_{C\text{-}Test}$). The regulations describe the resolution and sensitivity requirements for the Direct Integrity Test (DIT). The values used in these calculations are required for the TCEQ to approve removal credits for the Cypress 2008 RO Membrane Plant, which includes Evoqua (formerly Siemens Memcor distributed by USFilter) S10V MF membrane system consisting of five microfiltration cells containing 504 modules each.

In accordance with the requirements in 30 TAC §290.42(G)(3)(B), detailed descriptions of the calculation methods and values for the DIT performed during the pilot study were provided. All formulas and methods of calculation are from the US EPA *Membrane Filtration Guidance Manual* (Guidance Manual) and are in accordance with the DIT requirements of 40 Code of Federal Regulations (CFR) §141.719(b)(3). To receive removal credit for *Cryptosporidium parvum* removal, the DIT procedure must be conducted at a pressure high enough to detect a 3-micron breach in the membrane. **Based on our review of the calculations and data submitted, TCEQ accepts the following values for DITs performed on the membrane system at Cypress 2008 RO Membrane Plant.**

Approved Initial Test Pressure (P_{test} or $P_{initial}$) for the Cypress 2008 RO Membrane Plant

1. **The TCEQ accepts 16.5 psi as the Minimum Test Pressure (P_{test}).**
   The approved minimum P_{test} is based on the following equation:

   Equation 4.1 (for a 3.0 micron defect): $P_{test} = (0.193 * \kappa * \sigma * \cos(\theta) + BP_{max})$

   where: κ = the membrane specific pore shape correction factor
   = 1.0;

   σ = the surface tension at the air-liquid interface
   = 74.9 dynes/centimeter;

   Θ = the liquid-membrane contact angle
   = 0 degrees; and

   BP_{max} = the maximum back pressure on the system
   = 2.0 pounds per square inch (psi).

   The TCEQ accepts the use of the most conservative values for κ, σ, and θ (as described above) and the $BP_{(max)}$ provided by the membrane vendor.

   Please note that the plant may conduct its DIT's at any pressure that is greater than or equal to the approved minimum test pressure shown above.

Approved Upper Control Limit (UCL) for the Cypress 2008 RO Membrane Plant

2. **The TCEQ approves the use of an upper control limit (UCL) of 0.98psi/min.**
The approved UCL is maximum allowable pressure decay rate during a DIT and based on the following equation from the Guidance Manual:

Equation 4.17: Upper control limit (UCL) = $(Q_p \times ALCR \times P_{atm}) / (10^{LRC} \times V_{sys} \times VCF)$

where: Q_p = the design capacity filtrate flow, calculated as shown below
= 7,798 liters per minute (L/min);
ALCR = the air-liquid conversion ratio, calculated as shown below
= 40.23;
P_{atm} = the absolute atmospheric pressure
= 14.7 psia;
LRC = the log removal credit demonstrated by the DIT
= 3.0;
V_{sys} = the volume of pressurized air in the system during a DIT, as discussed below
= 3,122 L; and
VCF = the volumetric concentration factor, as discussed below
= 1.5

a. **The TCEQ accepts 7,798 L/min as the Q_p.**
The approved Q_p is based on information provided by the approved TCEQ pilot study dated August 5, 2002, and on the following equation.

Maximum flow rate (Q_p) = $j \times A_m \times N$

where: j = maximum approved flux, based on the approved pilot study
= 19.60 gallons per day per square foot (gpd/ft^2);
A_m = the total surface area of the membrane fibers in each membrane module, per the manufacturer specifications
= 300.3 ft^2;
N = number of membrane modules in a single membrane unit, or cell, based on the approved pilot study
= 504;

b. **The TCEQ accepts the use of 40.23 as the ALCR;**
The approved minimum ACLR is based on the Darcy Pipe Flow Model assuming turbulent flow such as from a broken hollow fiber (as defined in the Guidance Manual) and the following equation from the Guidance Manual:

Equation C.4: $ALCR = 170 \times Y \times \{(P_{test} - BP) \times (P_{test} + P_{atm}) / (460 + T) \times TMP\}^{1/2}$

where: Y = Net expansion factor for compressible flow through pipe to a larger area
= 0.910 (from Appendix C, Equation C.5 in the Membrane Filtration Guidance Manual)
P_{test} = minimum initial test pressure for the DIT
= 16.5 psi;
P_{atm} = 14.7 psia;
BP = 2.0 psi;
T = Temperature
= 95°F (35°C);

TMP = Transmembrane pressure
= 12.0 psi maximum (per manufacturer)

c. **The TCEQ accepts 3,122 L as the V_{sys}.**
The approved V_{sys} is based on the value provided by the membrane manufacturer.

d. **The TCEQ is approving a VCF of 1.5.**
Although the submerged membrane system operates in a particle deposition mode, site-specific investigations have demonstrated that VCF values for the submerged tanks vary with time and position. In lieu of a site-specific VCF study, the TCEQ will accept a VCF of 1.5 as a sufficiently conservative estimate.