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TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

File PWS 1140038/CO
RN105692891
CN602515967
File PWS 0680002/CO
RN101386613
CN600338354
File PWS 1140001/CO
RN101389492
CN600668693
File PWS 1590001/CO
RN101392082
CN600632905
File PWS 1650001/CO
RN101384899
CN600246813
File PWS 2080001/CO
RN101384568
CN600128938

May 26, 2010

Mr. Ignacio Cadena, P.E.
Freese and Nichols, Inc.
4055 International Plaza, Suite 200
Fort Worth, Texas 76109

Subject: Exception Request to Use Membrane Treated Reclaimed Wastewater from the Big Spring Wastewater Treatment Plant as a Raw Water Source for Public Drinking Water Systems
Wastewater Reclamation Pilot Study Report
Colorado River Municipal Water District Big Spring Regional Water Reclamation Project - PWS ID: No. 1140038
Howard County, Texas

Dear Mr. Cadena:

We have completed our review of the submitted wastewater reuse pilot study report with your cover letter dated February 2, 2010, and e-mails received in May of 2010. The Colorado River Municipal Water District (CRMWD) Big Spring Regional Water Reclamation Project (reclamation facility) is requesting an exception to the requirements for the raw water source. The Texas Commission on Environmental Quality's (TCEQ) requirements for public water system (PWS) raw water sources are contained within Title 30 of the Texas Administrative Code (30 TAC) §290.41. This review is only for the proposed use City of Big Spring Wastewater Treatment Plant (WWTP) effluent that has been treated by hollow fiber (HF) microfiltration (MF) or ultrafiltration (UF) membranes followed by reverse osmosis (RO) membranes (integrated membrane) at the CRMWD reclamation facility to be used as a raw water source for the City of Big Spring (PWS ID 1140001), City of Snyder (PWS ID 2080001), City of Odessa (PWS ID 0680002), City of Stanton (1590001) and the City of Midland (PWS ID 1650001) Surface Water Treatment Plants (SWTP). Based on our review, we are **granting** this request for an exception.

The proposed project's purpose is to supplement the raw water received for drinking water treatment at the above municipalities. The raw water source for these systems is provided via a Colorado River Municipal Water District raw water pipeline. At this time, the raw surface water is carried by this pipeline from OH Ivie Reservoir, EV Spence Reservoir, and Lake JB Thomas to each PWS. The proposed project would supplement the surface water sources by introducing reclaimed treated wastewater effluent to the pipeline. Ten to fifteen percent of the pipeline water would be the reclaimed water. The CRMWD reclamation facility would take the effluent from the Big Spring WWTP, treat it with hollow fiber (HF) membranes, reverse osmosis (RO) and potentially Ultraviolet Light and release the treated water into the raw water pipeline. This letter is a review of the pilot study for the membrane

portion of the CRMWD reclamation facility. The letter sets design, operation, reporting, calibration and record keeping requirements for the proposed facility which is a source of raw water for drinking water facilities.

The 30 TAC 290 Subchapters D, E and F rules only apply to public water systems. The CRMWD reclamation facility will produce only the source water for public water systems; therefore, many of the requirements for facilities that produce finished drinking water found in Subchapters D, E and F are not applicable. The following conditions are TCEQ site-specific minimum operation, design, reporting, calibration and record keeping requirements for the proposed innovative integrated membrane CRMWD reclamation facility which will produce an alternative raw water source for public drinking water system facilities and are based on the pilot study data supplied.

OPERATIONAL REQUIREMENTS

1. The CRMWD reclamation facility can only discharge source water into the CRMWD raw water pipeline when:
 - a. The WWTP effluent turbidity is below 10 Nephelometric Turbidity Units (NTU). If the WWTP effluent turbidity level is above 10 NTU the water must be sent back the WWTP. As described in the Freese and Nichols, Inc pilot study report on page 30, turbidity levels above 10 NTU may cause performance issues with the HF membranes.
 - b. The HF membrane units have passed the most recent direct integrity test (DIT). Each HF membrane unit must pass a DIT with a sensitivity of 4.0-log and a resolution to detect a 3.0 micron breach every seven days, and after each chemical clean-in-place (CIP) procedure, to assure similar water quality from the CRMWD reclamation facility as is seen in the CRMWD raw water pipeline. If a HF membrane unit fails a DIT, it must be taken off line, inspected and, if necessary, repaired. The HF membrane unit cannot be returned to service until it passes a subsequent DIT. The pilot study HF membrane test units with a DIT sensitivity of 4.0-log removal produced water with the same levels (non-detectable) of *Cryptosporidium* oocysts and *Giardia lamblia* cysts as found in the CRMWD raw water pipeline.
 - c. The free chlorine residual received from the WWTP is above 1.0 mg/L. If the residual falls below 1.0 mg/L there may not be enough viral inactivation achieved to provide the non-detectable viral levels achieved during the pilot study. If the chlorine residual is below 1.0 mg/L the water must be sent back to the WWTP.
2. If the CRMWD reclamation facility produces source water when in violation of the conditions in Item #1, TCEQ must be contacted within 24 hours by telephone at (512) 239-4691 or email at pdws@tceq.state.tx.us and immediately notify all PWSs utilizing the source water. Within five working days, submit written notification regarding the problem that required the CRMWD reclamation facility, or part of the facility, to be taken out of service, the corrective actions taken, quantity of any unacceptable water discharged to the CRMWD raw water pipeline and PWSs using the water at that time to:

Technical Review and Oversight Team
TCEQ – MC 159
PO Box 13087
Austin, TX 78711-3087

3. The system must conduct a DIT at least once every seven days and after each clean-in-place (CIP) procedure to verify that the integrity of the membranes has not been compromised and continuous removal of *Cryptosporidium* oocysts and *Giardia lamblia* cysts is being achieved.
4. The DIT must be conducted using a procedure approved by the executive director including resolution and sensitivity requirements. The DIT must show a 4.0-log removal sensitivity. The calculations of the direct integrity test values are described on page 12 in *DIT Resolution and LRV_{DIT} Sensitivity Calculations* under the HF Membrane Details section.
5. The CRMWD reclamation facility must immediately conduct a DIT on any HF membrane unit that produces filtered water with a turbidity level above 0.15 NTU on two consecutive 5-minute readings.
6. Continuous indirect integrity monitoring of each HF unit's filtrate turbidity levels must be measured using the Hach Model FilterTrak method 10133 laser turbidimeter, or an acceptable TCEQ alternative. The results must be recorded every 5 minutes.
7. The influent to the CRMWD reclamation facility must have continuous chlorine monitoring. The results must be recorded every 30 minutes.
8. The flow to the HF membrane units must be monitored continuously and the results must be recorded every 30 minutes.
9. The performance of the individual RO units shall be continuously monitored by conductivity meter or total dissolved solids meters. The highest confirmed reading shall be recorded each day.
10. Data collected from on-line instruments may be recorded electronically by a SCADA system or on a strip chart recorder. The recorder must be designed so that the operator can accurately determine the value of the readings at the required monitoring interval.
11. If there is a failure in the continuous monitoring equipment, grab sampling must be conducted every four hours in lieu of continuous monitoring, but for no more than five working days following the failure of the equipment.
12. If conductivity or total dissolved solids levels of an RO unit's permeate are 20% larger than the last reading then the RO unit must be removed from service, the problem repaired and an acceptable conductivity or total dissolved solids achieved in the permeate before discharge to the CRMWD raw water pipeline can be resumed.
13. All monitoring required as a condition of this exception in this letter must be conducted using methods that conform to the requirements of §290.119.
14. A plant operations manual that meets the requirements of §290.42(l) must be kept on site and must be made available to TCEQ staff upon request.
15. A Class B surface water operator must be employed by the CRMWD reclamation facility. Class C surface water operators can operate the CRMWD reclamation facility if the Class B operator is on call. Operators having both a water and wastewater license may work in the CRMWD reclamation facility and Big Spring WWTP, but not during the same shift to prevent the introduction of contaminants.

16. The TCEQ will not issue approval for discharge of CRMWD reclamation facility into the CRMWD raw water pipeline until after chemical analytical results are received from the TCEQ contract laboratory. After receiving notification of completion of construction, the TCEQ will schedule a contractor to collect the necessary samples at the required sample tap located on the reclamation facility discharge to the CRMWD raw water pipeline. These samples will be analyzed for the required minerals and metal constituents. They will be analyzed for certain organic chemicals such as volatile compound and pesticides. Based on the results of these analyses, the required sampling frequency and constituents analyzed for any receiving PWSs' points of entries to distribution systems may be modified.
17. Once the CRMWD reclamation facility is producing source water, Long Term 2 Enhanced Surface Water Treatment Rule (LT2) source water sampling must be performed on the blended source water for all of the public water systems that have the potential to receive this source water as described in §290.111(b). CRMWD must contact each of the PWSs that can receive source water from the reclamation facility to notify them of the new source water monitoring requirement. CRMWD must also notify the Technical Review and Oversight Team (MC-159) in writing when the reclamation facility begins producing source water at:

TCEQ Technical Review & Oversight Team (MC 159)
P.O. Box 13087
Austin, Texas 78711-3087

18. Results of pilot study sampling show an increase in total trihalomethane (TTHM) and nitrate levels above those seen in the raw water pipeline. The CRMWD must notify all of the PWSs that have the potential to receive the reclaimed water as source water of the levels found so that the PWSs can assess the impact to their finished drinking water compliance.
19. The CRMWD will be required to disinfect new or repaired facilities in accordance with American Water Works Association (AWWA) regulations as described in §290.46(g).
20. The CRMWD reclamation facility HF Filtrate tank and the water storage tank used to store fully treated water must be inspected annually by the facility's licensed water operators or a contract inspection service as described in §290.26(m).
21. All electrical wiring must be securely installed in compliance with a local or national electrical code.
22. The CRMWD reclamation facility must maintain internal procedures to notify TCEQ immediately if an emergency event would negatively impact the delivery of source water. A list of such events is located in §290.46(w)
23. All backflow prevention assemblies that are required by this letter shall be tested upon installation and then once every 12 months as described in §290.44(h)(4).
24. The CRMWD reclamation facility will be investigated by TCEQ periodically to assure the conditions of this letter are met. The investigation will be a public water system source investigation, not a wastewater investigation because the effluent of the CRMWD reclamation facility is being discharged into a pipeline, not a water body.

DESIGN REQUIREMENTS

25. Engineering specifications and drawings must be submitted for review and approval prior to construction beginning as described in §290.39(h)(1). These specifications and drawings shall include all related piping, treatment facilities, storage, industrial connections and transmission lines from the Big Spring WWTP to the CRMWD raw water pipeline. These documents are to be submitted to:

TCEQ Utilities Technical Review Team (MC 159)
P.O. Box 13087
Austin, Texas 78711-3087

26. In the future, the CRMWD reclamation facility must notify TCEQ prior to making any significant change as described in §290.39(j).
27. All waste discharge must be in accordance with federal and state requirements as described in §290.42(i). For assistance, please contact TCEQ's Wastewater Permitting Section (MC 148) for information required for the proper disposal of generated waste and any required discharge permit at (512) 239-2369.
28. A full-scale HF membrane system with Pall Microza[®] Model UNA-620A HF MF membrane modules (See the HF Membrane Details section on page 11 for further details.) must be installed with the following design specifications:
- a. Pre-treatment facilities consisting of a 400 micron strainer;
 - b. Pall Microza[®] Model UNA-620A HF MF membrane modules with the following specifications:
 - i. A HF MF pressure membrane module six inches in diameter, approximately 80 inches (in) in length and containing polyvinylidene fluoride (PVDF) fibers with a total feed side surface area of 538-square feet (sf);
 - ii. A membrane fiber nominal pore size of 0.1 microns;
 - iii. Outside-to-inside flow mode with dead-end operation;
 - iv. Allowable transmembrane pressure (TMP) operating range of 1 to 43.5 pounds per square-inch (psi);
 - v. Allowable operating temperature range of 0° to 40° C;
 - vi. A 1,000 mg/L chlorine tolerance; and
 - vii. Manufacture's allowable feed water turbidity level spike of 600 NTU.
 - c. Facilities to allow a filtrate duration of 20 minutes;
 - d. Facilities for a backwash cycle procedure on each HF MF membrane unit every 20 minutes using a Simultaneous Air Scrubbing and Reverse Filtration (SASRF) procedure for 60 seconds followed by Forward Flush (FF) for 20 seconds;
 - e. Facilities to conduct both a sodium hypochlorite and 1% citric acid enhanced filtrate maintenance (EFM) wash procedure utilizing RO permeate as make up water. One EFM will be conducted once every 24 hours for a duration of 30 minutes;
 - f. Facilities to conduct a HF MF membrane unit chemical clean-in-place (CIP) procedure no less than once every 30 days for a duration of approximately six hours utilizing RO permeate as make up water;
 - g. Facilities to provide an average instantaneous filtrate flux rate of 37.2 gallons per square-foot per day (gfd) (temperature corrected to 20° C);

29. A full-scale RO membrane system of Toray TML 10 RO elements, or another TCEQ acceptable Toray element (See the RO Membrane Details section on page 14 for further details) must be installed in pressure vessels arranged in a two-stage configuration with twice as many pressure vessels and elements in each Stage 1 as are in the corresponding Stage 2 (2:1 array) with the following specifications:
 - a. Toray TML 10 RO elements model with the following specifications:
 - i. 4-inch diameter or if a larger Toray membrane is used, the elements must have the same leaf length as the pilot TML 10;
 - ii. A leaf length of 40 inches;
 - iii. An active membrane area of 75 sf;
 - iv. Minimum salt rejection of 99%;
 - v. Recovery rate of 75%;
 - vi. Maximum operating temperature of 113° F;
 - vii. Maximum allowed continuous free chlorine value of non-detectable;
 - viii. An operating pH range of 2 to 11;
 - ix. A pH cleaning range of 1 to 12;
 - x. A maximum operating pressure of 600 psi;
 - xi. A maximum pressure drop per element of 20 psi; and
 - xii. A maximum silt density (SDI) of 5.
 - b. Facilities for dechlorination of the water prior to the RO membrane units must be provided;
 - c. Facilities to assure complete dechlorination was achieved must be provided;
 - d. Facilities to feed antiscalent must be provided;
 - e. Facilities for performing an RO membrane unit CIP procedure using both caustic and acid heated solutions; and
 - f. Facilities to achieve an average flux rate of 10.1 gfd.
30. The CRMWD reclamation facility must be located at least 500 feet from any wastewater treatment units or lands irrigated with sewage effluent.
31. The CRMWD reclamation facility shall be located at a site that is accessible by an all-weather road as described in §290.42(a)(3).
32. All water discharged to the CRMWD raw water pipeline must be treated by the HF and RO membrane processes. This means, the CRMWD reclamation facility units must be designed to treat all of the WWTP effluent received. Blending of WWTP effluent with reclamation facility effluent is not allowed.
33. No return of decanted water or solids to the beginning of the CRMWD reclamation facility is proposed. If recycle return is desired in the future, please contact the TCEQ Technical Review & Oversight Team (MC 159) at the following address:

TCEQ Technical Review & Oversight Team (MC 159)
P.O. Box 13087
Austin, Texas 78711-3087
34. The CRMWD reclamation facility, including all filtrate and permeate storage tanks, shall be enclosed by an intruder-resistant fence as described in §290.42(m). The gates shall be locked during periods of darkness and when the plant is unattended.

35. Chemical storage facilities shall comply with the applicable requirements in §290.42(f)(1).
36. Chemical feed facilities shall comply with the applicable requirements in §290.42(f)(2).
37. Pipe galleries shall provide ample working room, good lighting, and good drainage provided by sloping floors, gutters, and sumps. Adequate ventilation to prevent condensation and to provide humidity control is also required as detailed in §290.42(d)(12).
38. The identification of piping shall be accomplished by the use of labels or various color of paint as described in §290.42(d)(13).
39. Sanitary facilities for water works installations must be provided as described in §290.42(h).
40. The safety requirements of §290.42(k)(1) must be followed.
41. No cross-connection shall be permitted to exist between the WWTP effluent and the CRMWD reclamation facility effluent or any stage of prior treatment as described in §290.42(d)(2).
42. All reclaimed customer connections between the CRMWD reclamation facility and the CRMWD raw water pipeline shall be provided with backflow/back-siphonage protection to eliminate the possibility of chemical contamination and pathogen recontamination as described in §290.44(h)(1)(A).
43. Separation distances between the treated reclaimed water distribution/transmission piping and potable water piping shall be as specified in §290.44(e).
44. Separation distances between the treated reclaimed water distribution/transmission piping and wastewater collection mains and other potential sources of recontamination shall be as described in §290.44(e).
45. Sampling taps must be located after the CRMWD reclamation facility's source water (WWTP effluent) storage tank, on the HF membrane filtrate storage tanks' effluent, RO membrane permeate storage tanks' effluent and the CRMWD reclamation facility's discharge piping to the CRMWD raw water pipeline as described in §290.43(c) and §290.42(d)(14). These sample taps must be readily accessible to the plant operators and TCEQ representatives.
46. All treatment chemicals and media used in the full-scale facility must conform to American National Standard Institute/National Sanitation Foundation (ANSI/NSF) Standard 60 for direct additives and ANSI/NSF Standard 61 for indirect additives and be certified by an organization accredited by ANSI as described in §290.42(j). This includes dechlorination compounds, disinfectants, anti-scalants, acids, caustics and other membrane cleaning chemicals.
47. Flow measuring devices will be required on the feed to each HF membrane unit, the HF membrane backwash supply, the combined HF membrane filtrate, each RO permeate line, and on the final and the reclamation facility discharge piping to the CRMWD pipeline as described in §290.42(d)(5).

48. The CRMWD reclamation facility must be designed to conduct and record continuous turbidity monitoring of the WWTP effluent.
49. The HF membrane system must be designed to conduct and record continuous indirect integrity monitoring on each HF membrane unit using the Hach Model FilterTrak method 10133 laser turbidimeter, or an acceptable TCEQ alternative as described in §290.42(g)(3)(C).
50. The RO membrane system must be designed to conduct and record continuous conductivity or total dissolved solids on each RO membrane unit.
51. The HF and RO 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 from all chemical cleaning processes from contaminating other membrane units in other models of operations. This may be accomplished by the installation of a double block and bleed valving arrangement, a removable spool system, or other alternative methods approved by the executive director.
52. The CRMWD reclamation facility's feed water must receive the same pretreatment, at a minimum, under full-scale operation as received during this pilot study. The treatment is provided at the Big Spring WWTP and is as follows: Raw wastewater is first screened and degritted, then flows to a primary clarifier. Primary effluent then proceeds to a single rock media trickling filter for biological stabilization and then is pumped to the aeration basin for additional biological treatment. The contents of the aeration basin flow to the final clarifier, where the active biomass is separated from the treated effluent and recycled to the aeration basin. The effluent is chlorinated and then passes through a sand filter. The filtered effluent containing the chlorine residual was the source water for the pilot study.
53. The CRMWD reclamation facility must be designed with a continuous chlorine analyzer to check chlorine residual received from the WWTP.
54. The CRMWD reclamation facility must be designed to conduct and record the results of direct integrity tests (DIT) as described in §290.42(g)(3)(B). The DIT values are calculated as described on page 12 in the *DIT Resolution and LRV_{DIT} Sensitivity Calculations* under the HF Membrane Details section.
55. An adequately equipped laboratory must be available so that daily tests such as disinfectant residual, turbidity, pH, conductivity or total dissolved solids, and all other tests required by the conditions of this letter may be performed.
56. The water storage tank used to store fully treated water before it is sent to the CRMWD raw water pipeline must meet the requirements of §290.43(c).

CALIBRATION

57. Conductivity or dissolved solids meters used to monitor the RO membrane units' permeate shall be calibrated with solution of known concentrations at least once every 90 days.
58. Flow measuring devices and rate-of-flow controllers shall be calibrated at least once every 12 months.

59. pH meters shall be properly calibrated as described in §290.46(s)(2)(A).
60. Turbidimeters shall be properly calibrated as described in §290.46(s)(2)(B).
61. Chemical disinfectant residual analyzers, such as chlorine, shall be properly calibrated as described in §290.46(s)(2)(C).
62. Pressure monitors used for DIT measurements shall be calibrated or verified every at least once every 12 months.

REPORTING

63. The TCEQ will require the CRMWD reclamation facility to record the following daily:
 - a. The maximum flow rates to the HF membrane units;
 - b. The maximum flow to the RO membrane units;
 - c. The lowest chlorine residual at the entry to the reclamation facility;
 - d. The highest confirmed turbidity in the HF membrane effluent;
 - e. Any HF membrane unit DIT's starting test pressure, end pressure, duration of the test and decay pressure rate in pounds per square inch per minute (psi/min);
 - f. Any corrective actions taken, such as pinning, to correct a failed HF membrane DIT;
 - g. Any CIP that has been performed on a HF or RO membrane unit;
 - h. The highest confirmed conductivity or total dissolved solids measurement for each RO membrane unit;
 - i. The amount of each chemicals used;
 - j. The amount of water treated; and
 - k. The maximum flow rate of reclaimed water discharged into the CRMWD raw water pipeline.
64. The TCEQ will require the CRMWD reclamation facility to record the following:
 - a. The dates that storage tanks and other facilities were cleaned; and
 - b. The maintenance records for the system equipment and facilities.
65. The CRMWD reclamation facility shall record the daily data required in Item #63 in a format of their choosing. The records must be completed in ink, typed or computer printed and must be signed by a Class B Surface Water Operator. The TCEQ Membrane Monthly Operating Report can be used to record some of the required items, but this format is not required. It can be downloaded from:

http://www.tceq.state.tx.us/permitting/water_supply/pdw/swmor/swmor/mmor_v2.html
66. The CRMWD reclamation facility shall keep the daily operations and maintenance records for each month at the CRMWD reclamation facility for review by TCEQ staff during periodic TCEQ investigations.
67. The TCEQ will require the reclaimed wastewater to be identified as a raw water source on the consumer confidence report (CCR) for any PWS using this water as a raw water source.
68. If the CRMWD reclamation facility produces source water when in violation of the conditions in Item #1, it must contact TCEQ within 24 hours by telephone at (512) 239-4691 or email at pdws@tceq.state.tx.us and immediately notify all PWSs utilizing the source water.

Within five working days, submit written notification regarding the problem that required the CRMWD reclamation facility, or part of the facility, to be taken out of service, the corrective actions taken, quantity of any unacceptable water discharged to the CRMWD raw water pipeline and PWSs using the water at that time to:

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TCEQ – MC 159
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69. Data on system ownership and management shall be provided as detailed in §290.46(p)(1).

RECORD KEEPING

70. The following records must be retained for at least two years:
- a. The amount of chemical used each day;
 - b. The volume of water treated each day;
 - c. The dates that storage tanks and other facilities were cleaned; and
 - d. The maintenance records for the system equipment and facilities.
71. The following records must be retained for at least three years:
- a. Turbidity monitoring results for the individual HF membrane units; and
 - b. The calibration records for laboratory equipment, flow meters, on-line turbidimeters, on-line conductivity or total dissolved solids meters, and disinfectant residual analyzers.
72. This letter must be retained while the exception is valid and then for at least five years after the exception is no longer in valid.
73. Results of inspections of all water storage facilities must be retained for at least five years.
74. The following records must be retained for at least ten years:
- a. The daily maximum flow rates to the HF membrane units;
 - b. The daily maximum flow to the RO membrane units;
 - c. The lowest daily chlorine residual at the entry to the reclamation facility;
 - d. The highest daily confirmed turbidity in the HF membrane effluent;
 - e. Any HF membrane unit DIT's starting test pressure, end pressure, duration of the test and decay pressure rate in pounds per square inch per minute (psi/min);
 - f. Any corrective actions taken, such as pinning, to correct a failed DIT;
 - g. Each CIP performed on a HF or RO membrane unit;
 - h. The highest daily confirmed conductivity or total dissolved solids measurement from each RO membrane unit;
 - i. The amount of each chemicals used daily;
 - j. The amount of water treated daily;
 - k. The daily maximum flow of reclaimed water discharged into the CRMWD raw water pipeline; and
 - l. The results of all chemical analyses.
75. Accurate and up-to date detailed plans and specification for the facility shall be maintained at the system until the facility is decommissioned.

HF MEMBRANE DETAILS

Pall Microza® Model UNA-620A MF Membrane Details

Based on approximately 30 days of operation (Cycle #7 of the pilot study report), from October 8, 2009 through November 10, 2009, of the Pall HF MF membrane test unit, the TCEQ finds that the following piloted operating parameters are accepted to yield a maximum of 17,959 gallons per day (GPD) of total filtrate water at 20° C per 538 sf membrane module.

1. Pre-treatment consists of a 400 micron strainer;
2. The water is not dechlorinated until after the HF membrane unit, thus the treatment unit has a 1 to 5 mg/L chlorine residual across the membranes;
3. The maximum recorded turbidity from the submitted turbidity data was approximately 80 NTU, but the CRMWD reclamation facility is choosing to divert the wastewater back to the WWTP is the turbidity is over 10 NTU. Based on this choice, the maximum allowable feed water turbidity for the treatment plant will be 10 NTU;
4. Pall Microza® Model UNA-620A HF MF membrane modules with the following specifications:
 - a. A HF MF pressure membrane module six inches in diameter, approximately 80 inches (in) in length and containing polyvinylidene fluoride (PVDF) fibers with a total feed side surface area of 538-square feet (sf);
 - b. A membrane fiber nominal pore size of 0.1 microns;
 - c. Outside-to-inside flow mode with dead-end operation;
 - d. Allowable transmembrane pressure (TMP) operating range of 1 to 43.5 pounds per square-inch (psi);
 - e. Allowable operating temperature range of 0° to 40° C;
 - f. A 1,000 mg/L chlorine tolerance; and
 - g. Manufacture's allowable feed water turbidity level spike of 600 NTU.
5. A filtrate duration of 20 minutes;
6. A backwash cycle using a Simultaneous Air Scrubbing and Reverse Filtration (SASRF) frequency of once every 20 minutes at a flow rate of 8 gallons per minute (gpm) of filtrate and of 3 standard cubic feet per minute (SCFM) of air for a duration of 1.0 minute, followed by a Forward Flush (FF) at a flow rate of 18 gpm of feed water for a duration of 20 seconds;
7. A sodium hypochlorite enhanced filtrate maintenance (EFM) wash procedure once every 24 hours for a duration of 30 minutes with either 500 parts per million (ppm) sodium hypochlorite solution circulated or 1% citric acid for 30.0 minutes followed by a SASRF and FF for a total filtrate water use of 15 gallons per module. RO permeate is used for EMF make up volume. In times of poor water quality, such as wastewater treatment plant upsets, a EMF utilizing 1000 ppm sodium hypochlorite instead of 400 ppm sodium hypochlorite were performed. It is not expected that the 1000 ppm sodium hypochlorite EMF will be needed in full-scale because water with over 10 NTU will be returned to the WWTP;
8. A total of 1,331.4 minutes per day in filtrate mode and 108.8 minutes per day in SASRF, FF, and EFM;
9. A minimum chemical CIP frequency of no less than once every 30 days for a duration of

approximately six hours. The CIP uses a heated 1% caustic and sodium hypochlorite pH 11 solution re-circulated through the membranes and filtrate piping for 2 hours with a subsequent air scrub and feed side rinse. The process is repeated with a heated 1% citric acid pH 3 solution re-circulated for 1 hour. RO permeate is used for the CIP make up volume;

10. An average instantaneous filtrate flux rate of 37.2 gfd (temperature corrected to 20° C); and
11. A gross filtrate production of 18,499 GPD and an in-plant use of filtrate of 540 GPD to yield a net filtrate of 17,959 GPD per a 538-sf module at 20° C available for future customer use.

Based on our understanding of the submitted Pall pilot study data, for a 1.0 MGD design, 56 Pall UNA-620A HF membrane modules would be necessary.

The TCEQ determines the capacity HF membrane facilities based on an instantaneous filtrate flux corrected to 20° C. This amount is determined by subtracting the total in-plant use of filtrate (for backwashing membranes and maintenance cleaning such as EFM's, and any other in-plant use) from the gross potential filtrate production of a membrane unit in service for a 24-hour period of operation.

$$\text{Pall's filtrate flux at feed water temperature} = \frac{(\text{filtrate flux at } 20^{\circ}\text{C}) * 0.9826}{0.0004481 * T^2 - 0.03946 * T + 1.5926}$$

Where T is the HF membranes' feed water temperature in degrees centigrade, and filtrate flux at 20°C is 37.2 gfd.

**** Please note this is a Pall specific formula. It must be used at your facility, and can not be used with other manufactures membrane units. ****

DIT Resolution and LRV_{DIT} Sensitivity Calculations

During the pilot study, the permeate from the integrated membrane system had non-detectable levels of *Cryptosporidium* and *Giardia*. The pressure decay rates during the pilot study DITs established a 4.0-log removal of *Cryptosporidium* and *Giardia*. To verify that the HF membranes are intact and able to remove 4.0-log *Cryptosporidium* and *Giardia*, DITs must be performed ever seven days on the full-scale system. To assure that the pressure decay test you perform can confirm the 4.0-log *Cryptosporidium* and *Giardia* removals, the TCEQ must review the calculations and values used to perform the testing. The full-scale facility will have different values, but TCEQ has reviewed the calculation methods provided with the pilot report. We generally agree with the calculation methods and will discuss each one separately below. The values used in the full-scale facility must be submitted for review and approval before the plant is placed in operation.

These following values must be provided:

1. The maximum backpressure (BP_{max}) on the system during the DIT on each HF membrane unit;
2. The minimum test pressure (P_{test}) for each HF membrane unit;
3. The volume of pressurized air in the system during the test (V_{sys}) in each HF membrane unit;
4. The air-liquid conversion ration (ALCR);
5. The HF membrane unit capacity filtrate flow (Q_p);
6. The smallest rate of pressure decay that can be reliably measured (ΔP_{test});
7. The volumetric concentration factor (VCF); and
8. The upper control limit (UCL) for the decay limit that will verify the integrity of the HF membrane unit and the granted log removal values (LRV).

Calculation methods using EPA's Membrane Filtration Guidance Document (EPA 815-R-06-009) must be submitted. Without acceptable calculations methods, removal credit can not continue to be awarded. Please contact your engineer or membrane vendor for assistance with required values.

DIT Resolution

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

1. We agree with the use of the most conservative membrane specific pore shape correction factor (κ) of 1, the surface tension at the air-liquid interface (σ) of 74.9 dynes/cm, and the liquid-membrane contact angle (θ) of 0 degrees. The BP_{max} of 3.0 pounds per square inch (psi) is acceptable for the pilot unit. Please provide the BP_{max} for the full-scale unit before you begin producing source water.
2. By using equation 4.1 and the values in number 1 you calculated a P_{test} of 17.5 psi for the pilot study unit. This value is acceptable for the pilot study. Please provide the P_{test} for the full-scale unit before you begin producing source water.

DIT sensitivity

3. Please provide the actual V_{sys} in liters (L) for each full-scale HF membrane units before you begin producing source water.

V_{sys} is used in equation 4.9 of the US EPA's Membrane Filtration Guidance Manual to verify that the sensitivity of the DIT will be equal to or greater than the required log removal credit for *Cryptosporidium* and *Giardia* of 4.0-log. The V_{sys} of 10.59 L is acceptable for the pilot study unit.

$$\text{Equation 4.9: } LRV_{\text{DIT}} = \log [(Q_p \times ALCR \times P_{\text{atm}}) \div (\Delta P_{\text{test}} \times V_{\text{sys}} \times VCF)]$$

4. Please provide all necessary values and calculations to determine the ALCR for the full-scale HF membrane units.

The ALCR calculation method shown for the pilot is acceptable, but one of the reported values does not appear to be correct. The reported maximum water temperature was reported as 41°F. This should be the maximum water temperature expected in the feedwater to the HF membranes at the facility. Typical high water temperatures for Texas are around 95°F. Using the 95°F an ALCR of 17.4 is calculated for the pilot study unit. Please provide values for the full-scale HF membrane units before you begin producing source water.

5. The design capacity Q_p in liters per minutes (L/min) for each full-scale HF membrane unit is based on the TCEQ's approved flux rate of 37.2 gallons per square foot per day (gfd) per module.
6. Please provide documentation of the pressure measuring devices' sensitivity and manufacturers' accuracy (+/- percent) of the instrument to substantiate the ΔP_{test} in pounds per square inch (psi) for each full-scale HF membrane unit.
7. The VCF of 1.0 for the pilot and full-scale units is acceptable because there is no cross-flow or recirculation piloted or proposed.

8. Please submit the UCL for the full-scale plant for the pressure decay rate that will verify the integrity of the HF membrane unit and the granted LRV. Please use equation 4.17 from the US EPA's Membrane Filtration Guidance Manual. Using this equation, a 4.0 log removal credit (LRC), and the above values TCEQ finds a UCL of 0.13 psi/min for the pilot unit.

$$\text{Equation 4.17: } \text{UCL} = (Q_p * \text{ALCR} * P_{\text{atm}}) \div (10^{\text{LRC}} * V_{\text{sys}} * \text{VCF})$$

RO MEMBRANE DETAILS

Toray TML 10 Reverse Osmosis (RO) Membrane Details

Toray TML 10 Reverse Osmosis membranes were piloted in conjunction with the HF MF membrane units in a simulated full-scale design configuration. The Toray RO test unit consisted of six pressure vessels (PV) each containing three RO test elements. Two PV were piloted in parallel with HF MF membrane filtrate water for as their feed water source. Each of these two PVs' concentrate was fed to two more PVs in parallel. The concentrate from the second set of PVs was blended and used as feed water for a fifth PV. The fifth PV's concentrate was fed to the sixth and final PV. The first four PVs simulated two full-scale PVs operating in parallel with six RO elements each and the last two PVs simulated a single full-scale PV containing six RO elements. This is a commonly used pilot study arrangement achieving a 2:2:1:1 test array and simulating a full-scale 2:1 array with 6 membranes per PV.

Based on our review of Cycle #4, performed July 15, 2009 to August 23, 2009, the Toray TML 10 RO membrane elements can be installed under the following conditions:

1. Each array must achieve an average flux rate of 10.1 gfd for the Toray TML 10 RO membrane element's feed side surface area.
2. Each full-scale RO membrane unit must use a two-stage 2;1 array as simulated by the piloted.
 - a. All RO elements are to be the same model, or a larger TCEQ acceptable Toray RO element model having the same leaf length, salt rejection, removal efficiency and design (no mixing of non-piloted elements); and
 - b. Twice the number of PV and RO elements in each Stage 1 as is in Stage 2.
3. The full-scale RO membranes must meet the following specifications or if a larger Toray membrane is used, must show the same leaf length as the pilot TML 10 model:
 - a. 4-inch diameter;
 - b. An active membrane area of 75 sf;
 - c. Have a leaf length of 40 inches;
 - d. Minimum salt rejection of 99%;
 - e. Recovery rate of 75%;
 - f. Maximum operating temperature of 113° F;
 - g. Maximum allowed continuous free chlorine value of non-detectable;
 - h. An operating pH range of 2 to 11;
 - i. A pH cleaning range of 1 to 12;
 - j. A maximum operating pressure of 600 psi;
 - k. A maximum pressure drop per element of 20 psi; and
 - l. A maximum silt density (SDI) of 5.

4. The full-scale Toray membrane elements, internal surface of the PVs and associated RO membrane unit piping must be NSF 61 certified.
5. ANSI/NSF Standard 60 certified chemicals must be used. It is noted that Hypersperse MDC150 by GE Betz Inc. was used as the RO Anti-scaling product and is ANSI/NSF Standard 60 certified up to 10 mg/L.
6. ANSI/NSF Standard 60 certified sodium bisulfite must be used at a dose necessary to remove all chlorine residual before the RO membranes. During the pilot this dose was 22 mg/L.
7. A CIP must be conducted on each RO membrane unit using ANSI/NSF Standard 60 certified cleaning chemicals and the following procedure:
 - a. Perform a flush of the pressure vessels using clean RO permeate or dechlorinated potable water;
 - b. Start recirculation of cleaning solution through the system;
 - i. Allow low pH ~ 3, 1% citric acid cleaning solution to circulate through the system for approximately 1 hour while maintaining the solution at approximately 95°F;
 - ii. Drain the RO unit
 - iii. Collect waste and neutralize;
 - c. Perform another flush of the system to remove any traces of the cleaning solution;
 - d. Repeat the recirculation of the cleaning solution with 0.1% Caustic soda at a pH of 12 for 1 hour at 95°F through the system; and
 - e. Flush the system with dechlorinated tap water or permeate.

GENERAL INFORMATION

The pilot study report contained data supporting the use of HF MF or HF UF followed by RO membranes. Two treatment trains were pilot tested:

1. Pall Microza® UNA-620A HF MF followed by Toray TML 10 RO membranes; and
2. Siemens L20V HF UF membranes followed by Hydronautics BW30LE RO membranes.

We have not received all the necessary information to review the Siemens and Hydronautics pilot data, thus only the Pall and Toray data has been reviewed. If you would like us to review the Siemens and Hydronautics pilot data please provide the following:

1. The volume of filtrate water used in each of Siemens maintenance washes (MW);
2. The source of the makeup water for maintenance washes; RO permeate UF filtrate or another source;
3. On page 13 of the Freese and Nichols report it is stated that the MW are performed every 24 hours. In the Siemens report it is stated that the MW are performed every 20 hours. Please report the time between MW; and
4. There is a 140-hour MW and the normal 20-hour MW. It is unclear if the 140-hour MW performed in addition to the 20-hour MW, thus 2 MW performed in that day, or if the 140-hour MW done instead of the 20-hour MW, thus only one MW performed that day. Please clarify.

The source water for the membrane pilot study was the effluent of the Big Spring WWTP. The WWTP is a hybrid plant, including both fixed film and suspended growth biological processes. Raw wastewater is first screened and degritted, then flows to a primary clarifier. Primary effluent then proceeds to a single rock media trickling filter for biological stabilization and then is pumped to the aeration basin for additional biological treatment. The contents of the aeration basin flow to the final clarifier where the

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active biomass is separated from the treated effluent and recycled to the aeration basin. The effluent is chlorinated and then passes through a sand filter. The filtered effluent containing the chlorine residual was the source water for the pilot study. The effluent of the WWTP is subject to permit number TPDES 10069-001.

This letter is not to be construed as approval to construct for the proposed membrane filtration facility. This letter is only to address acceptance of the pilot study report. Please complete a copy of the Public Water System Plan Review Submittal Form for review of improvements to this surface water source. Every blank on the form must be completed to minimize any delays in review of your project. The document is available on our web site at the address shown below.

<http://www.tceq.state.tx.us/assets/public/permitting/watersupply/ud/forms/10233.pdf>

This exception for the innovative source approval is subject to periodic review and may be revoked or amended if warranted. All conditions contained in this letter are site-specific minimum operation, design, reporting, calibration and record keeping requirements for the CRMWD proposed reclamation facility as specified in §290.39(l)(4). Failure by the CRMWD reclamation facility to comply with these conditions can result in the water produced no longer being able to be used as a source of raw water for public drinking water facilities.

If you have any questions or need further assistance, please contact Ms. Marlo Wanielista Berg, P.E. of my staff at mberg@tceq.state.tx.us, or at (512) 239-6967.

Sincerely,



Cari-Michel La Caille, Assistant Director
Water Supply Division
Texas Commission on Environmental Quality

CML/mew

cc: Mr. John Grant, General Manager, Colorado River Municipal Water District, PO Box 869, Big Spring, TX 79721-0869
The Honorable Russ McEwen, Mayor, City of Big Spring, 310 Nolan Street, Big Spring, TX 79720-2657
The Honorable Francene Allen Noah, Mayor, City of Snyder, PO Box 1341, c/o Darrell Callahan Water Superintendent, PO Box 1341, Snyder, TX 79550-1341
The Honorable W. Wesley Perry, Mayor, City of Midland, PO Box 1152, Midland, TX 79702-1152
The Honorable Larry Melton, Mayor, City of Odessa, PO Box 4398, Odessa, TX 79760-4398
The Honorable Lester Baker, Mayor, City of Stanton, PO Box 370, Stanton, TX 79782-0370