

Enclosure E

Full-Scale Verification Test Report Format

The Full-Scale Verification Test Report (Report) must be prepared by the system's professional engineer, who must be licensed by the Texas Board of Professional Engineers, and accompanied by a cover letter that is sealed, signed, and dated. The Report must contain the following data in the formats noted. All references to equations to be used for membranes are from the U.S. Environmental Protection Agency's (EPA's) Membrane Filtration Guidance Manual (MFGM) – EPA 815-R-06-009, November 2005 (EPA MFGM).

The hard copy of the Report must contain all raw data collected during the verification testing along with the information and methods listed in this enclosure. Because of the large volume of data, electronic versions of the data should also be included. Electronic data submitted must be Excel 2010 compatible.

Report Introduction

The following site information needs to be included:

- The name of the public water system and water treatment plant(s) involved in the verification testing;
- The public water system identification (PWSID) number;
- The name of the wastewater treatment plant and any surface or groundwater sources that will be used for blending;
- A copy of the City's Chapter 210 reclaimed water reuse authorization and the RR WWTP wastewater discharge Permit No. WQ00104419-000;
- A USGS 7.5-minute quadrangle map showing the location of the wastewater treatment plant and full-scale DPR WTP; and
- A schematic of the treatment train that shows chemical feed points, pre-treatment facilities, all equipment, flow meters, and monitoring points.

Report Organization and Labeling

To facilitate the TCEQ's review, the Report needs to be organized using the following format:

- Provide a Table of Contents identifying the page number for each major division or tab;
- Submit the tables and graphs for the different parameters listed in the TCEQ's Enclosures A and B in the same order as they are listed in Enclosures A and B of this letter;
- Submit the results for each Enclosure A Sample Set water quality parameters/flow rates in an individual section or appendix, and submit the results for each Enclosure B Procedure in individual sections or appendices of the Report;
- Identify all submitted graphs, tables, and raw data sheets for each of the TCEQ's Enclosures A and B using the TCEQ's identifying numbers (TCEQ-A1, TCEQ-A2, TCEQ-B1, etc.) and TCEQ associated descriptions used in the enclosures to this letter;
- Column and/or row headings for tables that are on more than one page must appear on each page;
- Provide summaries and validated conclusions; and
- Except for the off-site laboratory sheets, each page of the Report and attachments need to have a number for referencing in follow-up conversations and correspondence. The City's Report will contain multiple attachments/appendices; therefore, if each attachment/appendix page does not have a header and title identifying which attachment or appendix (i.e.; A, B, C, etc.) it relates to, then each page number needs to include the attachment or appendix identification (i.e.; A-1, A-2, B-1, B-2, etc.) in the footer.

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Collected Data

The Report must contain the following tables and graphs for each of the water qualities, flow rates and operating parameters listed in:

- Enclosure A: Required Monitoring and Reporting of Water Qualities and Flow Rates;
- Enclosure B: Full-Scale Verification Test Protocol Monitoring and Reporting of Operation Processes; and
- Enclosure D: Design, Operating and Monitoring Requirements for Fluoride Adjustment.

Tables for Monitored Results

Each of the summary tables must contain the number of data points collected, the range of data values (i.e., the maximum and minimum values), the average value, and the 95th percentile value if more than 10 data points were collected. The following tables must be included with the Report. Other tables may be included to support the City's and engineer's conclusions and request to discharge the treated wastewater to the distribution system for human consumption. Please include:

- Water quality tables for all off-site analytical results for each of the monitoring locations listed in Enclosure A in the treatment train. In addition to the summary table, a table with all of the off-site analysis results must be provided.
- Water quality tables for all on-site monitoring results (collected at five-minute, 15-minute, two-hour, four-hour, and daily frequencies) for each of the monitoring locations in the treatment train.
- Tables comparing the results of on-site and off-site split sampling.
- A separate disinfection data table for each injection point that includes the dosages, residuals, and quantity of chlorine dioxide, chlorine and ammonia used each 24-hour period.
- A separate disinfection byproducts data table for each monitoring point that includes concentrations of:
 - Total trihalomethane (TTHM);
 - Haloacetic acid (HAA5);
 - Bromate;
 - Chlorite
 - Chlorine dioxide; and
 - Any monitored unregulated disinfection byproducts of concern.
- Individual tables for the 2008 SWTP and the 2010 SWTP coagulation, flocculation and clarification treatment and equipment operation.
- Microfiltration (MF) membrane unit's performance and operating tables summarizing the following:
 - Feed water flow rates;
 - Filtrate water flow rates;
 - Filtrate flux rates;
 - Transmembrane pressures (TMP);
 - Feed water temperatures;
 - Specific flux rates adjusted to 20° C;
 - %-recovery of specific flux after a chemical maintenance clean (MC);

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- %-recovery of specific flux after a chemical clean-in-place (CIP);
- %-loss of original (at startup of full-scale verification test) specific flux due to irreversible fouling;
- Each direct integrity test's (DIT) beginning pressure, ending pressure and test duration;
- MC frequencies, durations, and flow rates; and
- Backwash frequencies, durations, and flow rates.
- Reverse osmosis (RO) membrane skid's operating and performance tables summarizing the following:
 - Feed water flow rates;
 - Feed water temperatures;
 - Permeate flow rates;
 - Concentrate flow rates;
 - Stage 1 and 2 permeate flux rates at feed water temperature;
 - Net driving pressures (NDP);
 - Stage 1 and 2 specific flux rates at 20°C;
 - %-recovery of specific flux after a CIP; and
 - %-loss of original (at startup of full-scale verification test) specific flux due to irreversible fouling.

Graphs for Monitored Results

Each graph must show the time the data was collected on the x-axis and the results on the y-axis. The scale of each axis must be such that data at four-hour intervals can be clearly identified. Use different symbols (+, x, Δ, •, ◇, etc.) and colors for data points and lines when more than one set of data is graphed on a single graph. The following graphs are to be provided with the Report. Other graphs may be included to support the City's and engineer's conclusions and request to discharge the treated waste water to the distribution system for human consumption.

- Comparison of the wastewater treatment plant's 15-minute effluent turbidity levels and flow rates plotted against time;
- Comparison of the wastewater treatment plant's 15-minute effluent turbidity levels and the reported onsite and offsite *Cryptosporidium* and *Giardia* levels plotted against time;
- Comparison of all the on-site *Cryptosporidium* and *Giardia* levels and the offsite *Cryptosporidium* and *Giardia* levels plotted against time;
- Comparison of each disinfection zone's (one graph for each disinfection zone) chlorine dioxide and monochloramine residuals and the reported TTHM and HAA5 levels at the end of the zone plotted against time;
- Comparison of the 2008 SWTP Radial Flow Clarification Basin's influent and effluent turbidity levels plotted against time;
- Comparison of the 2010 SWTP Accelerator Clarification Basin's influent and effluent turbidity levels plotted against time;
- Comparison of the MF membrane unit's 15-minute feed water and five-minute filtrate turbidity levels plotted against time;
- Comparison of the MF membrane unit's daily feed water and filtrate silt density index (SDI) levels plotted against time;

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- Comparison of the MF membrane unit's 15-minute feed water turbidity and daily feed water SDI levels plotted against time;
- Comparison of the MF membrane unit's temperatures and TMPs with all maintenance clean and CIP events identified plotted against time;
- Comparison of the MF membrane unit's four-hour specific flux rates (adjusted to 20° C) and %-recovery of original (at startup of full-scale verification test) specific flux due to backwash, maintenance clean, and CIP events plotted against time. Use MFGM Equation 2.13 for calculating specific flux:

Equation 2.13: $M_{20} = J_{20} / TMP$

- Comparison of the RO membrane skid's 15-minute feed, concentrate and permeate total dissolved solids (TDS) levels plotted against time;
- Comparison of the RO membrane skid's feed water turbidity levels, permeate flux rates and net driving pressures (NDP) plotted against time;
- Comparison of the RO membrane skid's feed water temperatures, permeate flux rates and NDP plotted against time;
- Comparison of the RO membrane skid's daily average specific/normalized flux rates (adjusted to 20° C) and % recovery of original (at startup of full-scale verification test) plotted against time. Use MFGM Equation 2.21 for calculating specific flux:

Equation 2.21: $M_{20} = J_{20} / NDP$

- Comparison of the RO membrane skid's %-loss of original (at startup of full-scale verification test) specific flux rate and permeate feed water TDS levels;
- Individual graphs for the RO membrane skid's %-removal of:
 - Nitrate (and nitrite if detected in the RO feed water);
 - TDS, TOC, and DOC;
 - TTHM;
 - HAA5;
 - Bromate;
 - Inorganics detected in the permeate
 - Organics detected in the permeate;
 - Radionuclides detected in the permeate;
 - Secondary drinking water constituents detected in the permeate;
 - Any monitored unregulated disinfection byproducts of concern detected in the permeate; and
 - Any monitored unregulated contaminants of concern detected in the RO permeate.
- A single graph with the 2010 gravity filter's hydraulic loading rate (HLR), turbidity and backwash events marked.
- Individual graphs for the %-change in the water quality after blending the partial treated RR WWTP effluent and the Secondary Reservoir water source:
 - Nitrate;
 - TOC and DOC;
 - TTHM;
 - HAA5;
 - Bromate; and

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- Chlorite.

MF Membrane System

- The Report must contain the following manufacturer's information for the MF membranes:
 - The manufacturer's name, model number, and serial;
 - Documentation that the MF membrane elements and pressure vessels conformed to American National Sanitation Institute/National Sanitation Foundation (ANSI/NSF) Standard 61 and have been certified by a testing organization accredited by ANSI;
 - Material the membrane fiber is constructed of;
 - Length of membrane fiber;
 - Surface area of the feed water side of the membrane module/element;
 - Flow direction (inside out or outside in)
 - Nominal and maximum pore sizes;
 - Oxidant resistance;
 - Water temperature operating range;
 - Feed water turbidity operating limit;
 - Method of operation (dead-end or crossflow);
 - Maximum recommended instantaneous filtrate flux rate;
 - Maximum allowable TMP using:

Equation 2.4: $TMP = P_f$ (feed pressure in psi) $- P_p$ (permeate pressure in psi)
 - Confirmation of all the parameters used in the DIT formulas.
- The Report must provide the following information in tables for backwash, MC, and CIP data for each MF membrane procedure used during the verification test:
 - All chemicals and their concentrations;
 - Documentation that all chemicals used conform to ANSI/NSF Standard 60 and have been certified by a testing organization accredited by ANSI;
 - Flow rates;
 - Durations;
 - Frequencies;
 - Quantity of filtrate/permeate water used;
 - Disinfectant residual (if applicable);
 - pH of the chemical solution;
 - Temperature of the chemical solution;
 - Description of the M.C. and CIP waste neutralization procedures; and
 - Disposal method of chemical and backwash waste.

RO Membrane System

- The Report must contain the following manufacturer's information for the RO membranes:
 - The manufacturer's name, model number, and serial number(s);
 - The number of RO elements per pressure vessel;
 - Number of pressure vessels in Stage 1 of each skid;
 - Number of pressure vessels in Stage 2 of each skid;
 - Documentation that the RO membrane elements and pressure vessels conform to ANSI/NSF Standard 61 and have been certified by a testing organization accredited by

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ANSI;

- Materials of construction for the RO membrane elements and pressure vessels;
- Surface area of the feed water side of the membrane element;
- Oxidant resistance;
- Water temperature operating range;
- Feed water constituent limitations (i.e., turbidity, metals, minerals, SDI, etc.);
- Maximum recommended instantaneous permeate flux rate per stage (gfd);
- Operating pressure range;
- Dimensions of the RO membrane elements (element diameter and length, leaf length and area);

- Maximum allowable net driving pressure (NDP) using MFGM Equation 2.17:

Equation 2.17: $NDP = \{[(P_f + P_c) \div 2] - P_p\} - (\{[(TDS_f + TDS_c) \div 2] - TDS_p\} \times 0.01)$

- Vendor specific constant “U” for the temperature correction factor using MFGM Equation 2.19 to adjust the RO flux rate to 25° C using Equation 2.20:

Equation 2.19: $TCF = e^{(U \times \{[1 / (T + 273)] - (1 / 298)\})}$

Note: replacing “298” (for 25° C) with “293” (for 20° C) in MFGM Equation 2.19 then allows MFGM Equation 2.19 to give a TCF_{20} (for 20° C) and MFGM Equation 2.20 gives J_{20} (flux adjusted to 20° C) instead of J_{25} .

Equation 2.20: $J_{25} = J_T \times TCF$

- A description of the manufacturer's required membrane preconditioning method, if applicable.
- The Report must provide the following CIP data for the RO membrane skid and CIP procedure used.
 - All chemicals and their concentrations;
 - Documentation that all chemicals used conform to ANSI/NSF Standard 60 and have been certified by a testing organization accredited by ANSI;
 - Flow rate;
 - Duration;
 - Quantity of permeate water used;
 - Disinfectant residual (if applicable) of CIP solution;
 - pH of the chemical solution;
 - Temperature of the chemical solution;
 - Description of CIP and waste neutralization procedures;
 - Disposal method of chemical and backwash waste; and
 - The expected chemical CIP frequency if different from that used during the full-scale verification test.

Alarms and Automatic Shut-down Controls

- Test results of all alarms with automatic shut-down controls must be provided.
- Test results for on-line monitoring equipment with alarms only.
- Provide the trigger point for each alarm and automatic shut-down control.
- Provide a description and corrective actions taken for each alarm or automatic shut-down event during the verification testing.

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Events

- Provide the date, duration and amount of rainfall on the Lake Arrowhead, Lake Kickapoo and Secondary Reservoir watersheds during the verification test period;
- Provide the date, time, duration, and corrective actions taken for any water quality (i.e.; TSS, turbidity, pathogens, etc.) spikes from the RR WWTP and exceedances of the City's Chapter 210 reclaim water reuse authorized limits.

Quality Control/Quality Assurance

- The Report must include the following data for all on-site analytical tests:
 - A list of the analytical methods and equipment used during the verification test;
 - Laboratory quality assurance documentation for all samples (including standard operating procedures and statements of qualifications for analysts);
 - A description of the calibration procedures and frequencies; and
 - A copy of each calibration procedure for the analytical equipment and flow measuring devices.
- The Report must include the following data for all off-site laboratories used during the verification study:
 - Names of the laboratories;
 - Analytical tests conducted;
 - Analytical methods used;
 - Analytical test results in the graph and table formats as discussed above;
 - Copies of all the results for all quality assurance and quality control (QA/QC) procedures conducted for the analytical testing of samples;
 - Analytical equipment calibration methods and frequencies; and
 - Sample blank and spike results.