DPR Proposed Chemical Control Criteria

§64669.40, §64669.50 and portions of §64669.25, §64669.30, §64669.35, §64669.65 & §64669.80

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Division of Drinking Water

Division of Drinking Water

Speaker Bio

- Brian Bernados, P.E., MSCE
- Senior Sanitary Engineer
- 29 years with CDPH/SWRCB
- Former District Engineer in charge of San Diego and Imperial County
- Currently Technical Specialist
- Water Treatment operator Grade T5

Chemical Criteria Goal

- In addition to controlling pathogens the criteria must address toxic chemicals
- One goal of the criteria is to address the findings in the 2016 report by the
- *Expert Panel on the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse*

Feasibility of DPR Expert Panel

DPR Expert Panel Report (2016) & Research

- DPR-1 - Quantitative Microbial Risk Assessment (QMRA) Implementation
- DPR-2 - Measure Pathogens in Wastewater
- DPR-3 - Feasibility of Collecting Pathogens in Wastewater during Outbreaks
- DPR-4 - Treatment for Averaging Potential Chemical Peaks
- DPR-5 - Develop methods to identify low molecular weight unknown compounds

2016 Expert Panel Findings Summarized

DPR practices need to provide the following features in addition to the requirements already specified in IPR regulations for California

- The DPR system must be reliable
- Ensure the independent treatment barriers represent a diverse set of processes (i.e., robustness)
- Providing the ability to divert advanced treated water that does not meet specifications
- “averaging” of potential chemical peaks

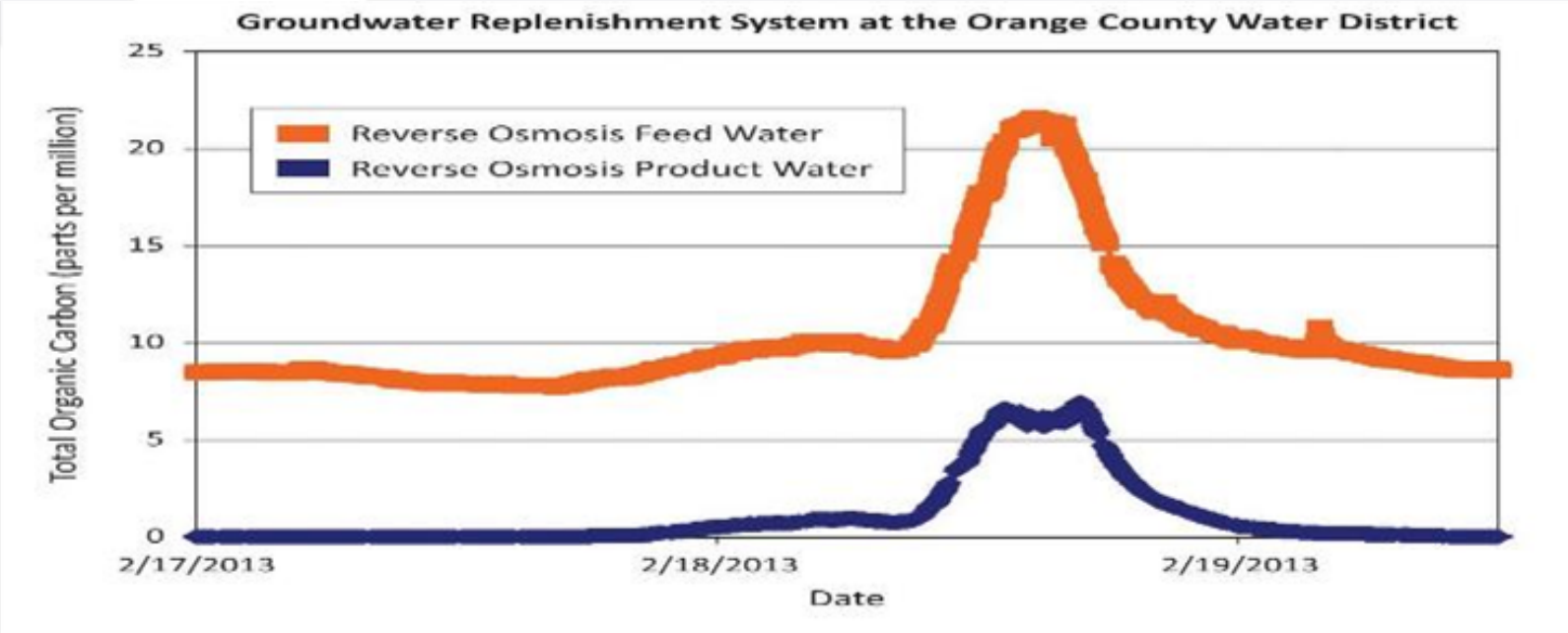
Chemical Control in DPR vs. IPR

The threat posed by chemicals in DPR is similar to that for IPR - advanced treatment must be provided to control the potential chronic exposure hazard from a wide variety of unregulated chemicals.

But..

Chemical Control in DPR vs. IPR

..is different from IPR in two important ways:



- Without an environmental buffer, pulses of low molecular weight chemicals may pose an acute threat
- Without an environmental buffer the urgency of recognizing and responding to treatment deficiencies increases

Chemical Control Objective

- The objective:
  - Remove chemicals to levels that are below public health concern

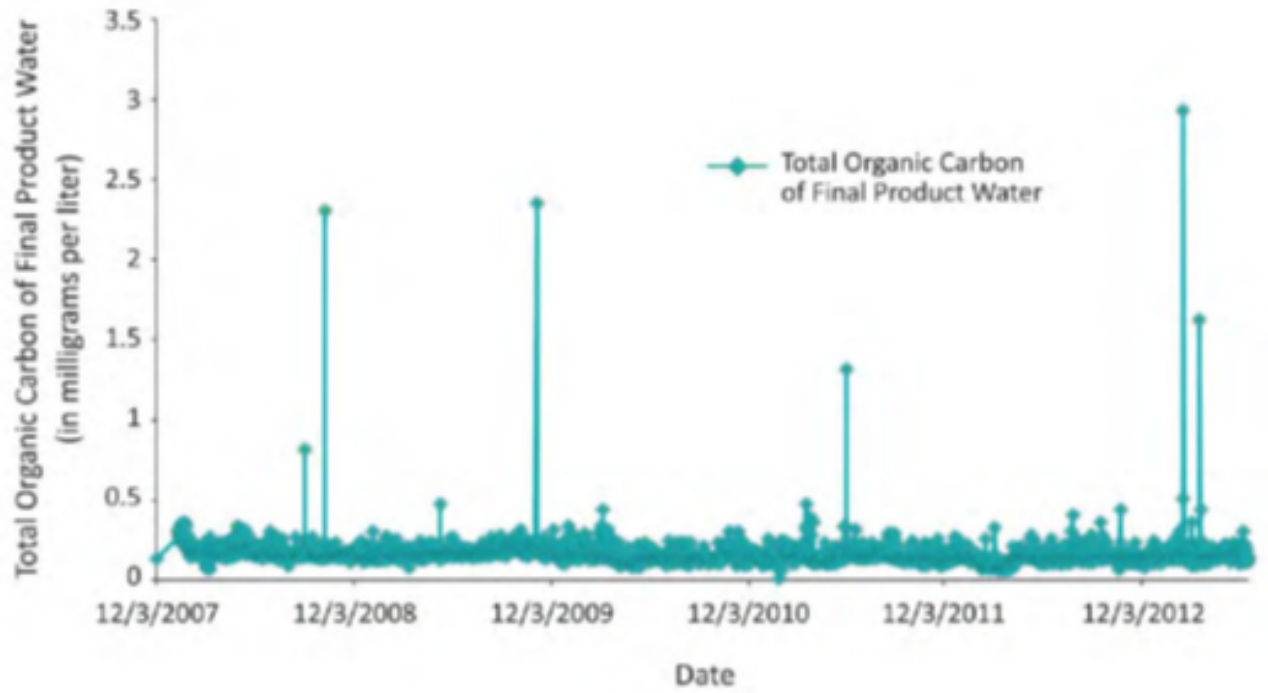


Figure 4-2: **Total organic carbon measured in daily 24-hour composite samples of final product water from the Orange County Water District's Groundwater Replenishment System (Patel, 2013).**

Chemical Control Approach

- The approach:
  - Enhanced source control and public education
  - Conformance with MCL and Notification Level (NL) requirements
  - Monitoring and development of additional NLs as appropriate
  - Multi-barrier advanced treatment
  - Criteria to address pulses of low molecular weight chemicals
  - Chemical control points and critical limits
  - Control systems and response plan

Source Control and Joint Plan § 64669.25

- Since source control may be the responsibility of a sanitation district and not the permitted DiPRRA
- (a) At a minimum, the Joint Plan shall include the following:
  - (3) The procedures to implement source control requirements pursuant to section 64669.40, including provisions to conduct source control investigations;
- (d) A DiPRRA, through the Joint Plan, shall implement a sewershed surveillance program to receive early warning of a potential occurrence that could adversely affect the DPR treatment and that contains the following:

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Source Control, Joint Plan & Monitoring § 64669.65

- Each year, a DiPRRA shall also identify chemicals within its sewage collection area(s) that are not otherwise required to be monitored and are:
- (2) Likely to be present in wastewater used in the DiPRRA's DPR project, based on reviews of possible contaminating activities identified in drinking water source assessments performed by or for the DiPRRA or its partner water agency(ies) in the Joint Plan; reviews of chemicals of emerging concern (CECs) in wastewater, including endocrine disrupting chemicals, in reports from State Water Board advisory bodies and the scientific literature; and lists of the most prescribed pharmaceuticals.
- Later slides will cover TOC monitoring and source control

2016 Panel: “Rigorous Source Control”

- From 2016 Feasibility report
- “Implementing a rigorous source control program designed to control the discharge of toxic chemicals and other contaminants into the wastewater collection system that serves the DPR system. The source control program must include stringent sewer ordinances and ongoing surveillance.”
- Therefore,,

Wastewater Source Control §64669.40

- "Rigorous Source Control" addressed in Draft Criteria, which includes the following:
  - A risk assessment
  - Ordinances that utilize "local limits" applied to dischargers that goes beyond the EPA pretreatment compounds to protect DPR
  - Audits
  - Early warning of potential peaks
  - Source control committee

2019 Source Control for DPR Panel

"Enhanced Source Control Recommendations for Direct Potable Reuse in California"

- The NWRI panel members were:
  - Chair: Jeff Neemann, Black & Veatch
  - James Colston, Irvine Ranch Water District
  - Stuart Krasner, Independent Consultant
  - Ian Law, IBL Solutions and University of Queensland
  - Amelia Whitson, EPA Region 9

Quantitative Risk Assessment and Management

- “Risk assessment and risk management are essential in any potable reuse program to protect public health. A comprehensive risk assessment should include a thorough evaluation of the local source control program, which is an important barrier to protect the treatment system.”
- “Effective source control requires a complete inventory of all industries that have the potential to impact the wastewater collection system, the contaminants being discharged, and a plan to safely manage them.”
- “Any potable reuse scheme, and in particular those planning for DPR should also incorporate a risk-based approach to identify and set limits for water quality constituents that could be present in industrial waste discharges. Including risk assessment and management procedures to establish local acceptance limits will be an enhancement of the NPP for DPR applications.”

Wastewater Source Control - 2
§64669.40 (a), (b), (c)

Same requirements as existing IPR regulations, plus:

- "Conducts a quantitative risk assessment . . . to ensure no contaminant will have a deleterious effect on the DPR project treatment facility or contribute to exceedance of MCLs or Notification Levels by the facility."
- Utilize local limits to protect water quality for DPR, "A DiPRRA shall work with the wastewater management agency to utilize local limits and other discharge control methods such that the DPR treatment is not adversely affected. Local limits must be designed to protect the public health and water quality for potable reuse.
- Audit by an independent party at least every 5 years, use EPA guidance

Early Warning System

- “As utilities implement potable reuse and especially DPR, some form of an early warning system in the wastewater collection system or WWTP could help utilities initiate a remedial action plan."
- "The goal of the action plan is to quickly resolve problems as they happen and to prevent adverse water quality excursions from occurring at the WWTP or the AWTP and in the product water."

Sampling and Monitoring

- “Monitoring is critical to verify that the enhanced source control program is working and to determine areas to focus on in the future.”
- “Two of the most significant risks in source control for potable reuse programs are noncompliant discharges and illegal dumping. Noncompliant discharges can be detected by enhanced monitoring at the discharge point at the IU; illegal dumping can be detected by monitoring systems at nodal points installed in the wastewater collection system and at the WWTP headworks. These monitoring processes help to establish risk management procedures that safeguard the quality of water produced by the AWTP.”

Wastewater Source Control - 3
§64669.40 (d)

Early Warning of Chemical Peaks :

- “A DiPRRA, through the Joint Plan, shall implement a sewershed surveillance program to receive early warning of a potential occurrence that could adversely affect the DPR treatment and that contains the following:
  - On-line monitoring instrumentation that measure surrogate(s) that may indicate a chemical peak resulting from illicit discharge;
  - Notification by the pretreatment program to the DiPRRA of any discharge that results in the release of contaminants above allowable limits;
  - Monitoring of local county public health disease surveillance programs or community raw wastewater surveillance monitoring programs to communicate when community outbreaks of disease occur”

WRF Project 4908 (WERF 17-30)

- Demonstrating Real Time Collection System Monitoring for Potable Reuse
- Eva Steinle-Darling, PhD, PE, Penny Carlo, PE, Andrew Salveson, PE, Carollo Engineers, Inc., Gina Dorrington, Ventura Water, Nancy Nye, El Paso Water
- This project deployed collection system pilot sensor networks with three participating utilities: Ventura Water in California, El Paso Water in Texas, and Clean Water Services in Oregon. Pilots consisted of 3-5 sensor stations with probes monitoring electrical conductivity, pH, oxidation-reduction potential, and temperature.
- KANDO, S:CAN, & off the shelf in Oregon

Wastewater Source Control - 4
§64669.40

Maintain a source control committee & continuous improvement:

- (e) A DiPRRA shall form and maintain a source control committee that includes representatives from all the wastewater management agency(ies) that supply wastewater to the DPR project and partner agency(ies) that operate the wastewater treatment plant and/or DPR project treatment facilities, representatives from industrial users and others that discharge chemicals of concern to the wastewater collection system.
- (f) A DiPRRA must institute a continuous improvement process to address all aspects of an enhanced source control program.

A Robust Third Chemical Process 2016 Expert Panel Findings

"DPR practices need to provide the following features **in addition to** the requirements already specified in IPR regulations for California

- "Ensuring the independent treatment barriers represent a diverse set of processes (i.e., robustness*)* in the treatment train that are capable of removing particular types of contaminants by different mechanisms.
- This diversity provides better assurance that if a currently unrecognized chemical or microbial contaminant is identified in the future, there is a greater degree of likelihood it will be removed effectively by the treatment train."

Chemical Control
§ 64669.50

- “A DPR project shall ensure that the municipal wastewater receives continuous treatment prior to its distribution as drinking water as follows:
- (a) The treatment train must consist of at least three separate treatment processes, using diverse treatment mechanisms, for chemical reduction. The treatment train shall include:
- (1) An ozone/biological activated carbon (ozone/BAC) process that meets the criteria in this section;
- (2) A reverse osmosis membrane process that meets the criteria in this section; and
- (3) An advanced oxidation process that meets the criteria in this section.”

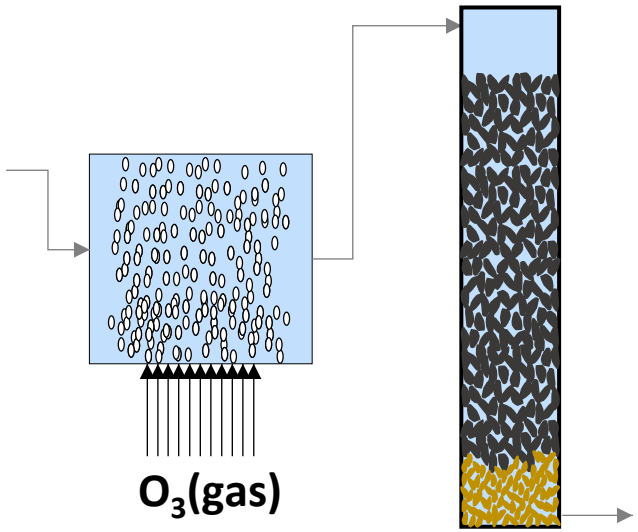
Options Beyond RO and AOP (DPR-4)

Blending	Works for any peak, but need a lot
Ozone/Biological Activated Carbon	Works on formaldehyde that may pass RO/AOP
Granular Activated Carbon	Works on TTHMs, PFAS, & most VOCs, but not highly polar VOCs & formaldehyde
Air Stripping	Works on VOCs depending on Henry's law constant
2nd pass RO	Works for most except neutral LMW

Must Be Robust

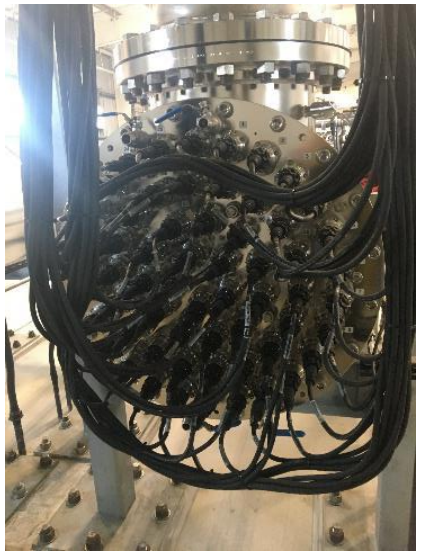
- "To be feasible, DPR systems must meet or exceed the attributes of **robustness** . . defined as the presence of **different types** of treatment processes acting via **different mechanisms** such that a **yet-unknown pollutant** likely will be removed by multiple stages."

biodegradation



separation

advanced oxidation



Must Be Reliable

2016 Expert Panel: “Reliability is achieved by

(1) providing multiple, independent treatment barriers,

(2) incorporating the frequent monitoring of surrogate parameters at each step to ensure treatment processes are performing properly, and

(3) developing and implementing rigorous response protocols (such as a formal Hazard Analysis Critical Control Point

Multi-Barrier Treatment
§64669.50 (a)

- Treatment train:
  - must consist of at least 3 separate treatment processes, using diverse mechanisms, for chemical reduction
  - Include an ozone/biological activated carbon (ozone/BAC), reverse osmosis, and advanced oxidation process,
- This is the order evaluated in the 2016 Expert Panel Report; in response to comments, we removed it as a requirement

Multi-Barrier Treatment - 2
§64669.50 (a)

- Design criteria is specified for:
  - RO (existing IPR criteria)
  - AOP (existing IPR criteria)
  - ozone/BAC is new criteria

Ozone/BAC for Chemical Peak Control §64669.50 (c)

1. City of San Diego Demonstration Project has been operating, studying, and challenging ozone BAC
   a. Quoted in 2016 Expert Panel Report
   b. WERF 14-12 report has details
2. Achieve 1.0 log formaldehyde, acetone & NDMA reduction
   a. City of San Diego Demonstration was >90% reduction
   b. Experts consider good if 90%; <90% is moderate
   c. Specifying 3 indicator chemicals provides a potential route to demonstrate an alternative
3. Empty bed contact time of BAC = 15 min. per San Diego study

Ozone/BAC - 2
§64669.50 (c)

Based upon a review of existing research/studies, refer to AWWA Water Science article July 2020,

Persistent contaminants of emerging concern in ozone-biofiltration systems: Analysis from multiple studies,

By Mutiara Ayu Sari, Joan Oppenheimer, Keel Robinson, Jörg Drewes, Aleksey Pisarenko, Vijay Sundaram, Joseph Jacangelo

Ozone/BAC Design Criteria:

1. Ratio of applied ozone dose to feed water TOC = > 1.0
2. Ozone to TOC = 0.9 was average of studies

Satellite Plant?

- Some have proposed RO/AOP followed by ozone/BAC downstream at a separate plant
- Projects meeting existing criteria (RO/AOP) can provide water for IPR projects
- Additional treatment could be provided downstream
- Satellite plant would be smaller at a lower flow

Ozone/BAC Alternative

- What is equivalent?
- Ninety percent reduction of the following indicators, which are appropriate:
  - Formaldehyde
  - Acetone
  - NDMA
- First two could pass FAT
- NDMA is created
- Also, TOC is typically reduced by 30%

Ozone/BAC at DWTP?

- DWTP may include ozone
- Theoretically could demonstrate via same indicators
- Ninety percent reduction of the following indicators, which are appropriate:
  - Formaldehyde
  - Acetone
  - NDMA
- And TOC reduced by 30%

Blend Option in Criteria §64669.50 (b)

- A blend of 10% water from FAT with 90% other water is effective treatment
- However, it must be “a continuous blending process”
- Blend water must be approved: “untreated source of drinking water upstream of a water treatment plant previously approved by the State Board or a finished drinking water previously approved by the State Board”

Blend Option - 2
§64669.50 (b)

- What about a blend that is less than 10% water from FAT with 90% other water is effective treatment
- Could the DiPRRA combine a portion treated with ozone/BAC with a lower blend ratio?
- “For a continuous blending process with an approved WWC greater than 0.1 but less than or equal to 0.5, the DiPRRA shall provide treatment pursuant to paragraph (a)(1) for a percentage of the municipal wastewater flow equal to or greater than:

$$100 - \frac{\left(\frac{1}{WWC} - 1\right)}{0.09}$$

Blend Option - Wastewater Contribution

§ 64669.05 Definitions

- "Wastewater contribution (WWC)" means the fraction equal to the quantity of municipal wastewater applied at a DPR project divided by the sum of the quantity of municipal wastewater and a dilution water that is either an untreated source of drinking water upstream of a water treatment plant previously approved by the State Board or a finished drinking water previously approved by the State Board.

Test Protocol Approval
§64669.50 (c)

- "A DiPRRA shall submit a testing protocol, as well as the subsequent testing results, to the State Board for review and written approval."
- "The testing protocol shall include challenge or spiking tests, using formaldehyde, acetone, and NDMA, to demonstrate the proposed ozone/BAC treatment process will achieve the minimum 1.0 log reduction for each indicator under the proposed ozone/BAC treatment process's normal full-scale operating conditions."
- This is similar to the existing approach for AOP.

“The DPR system must be reliable.”

“Reliability is achieved by

(1) providing multiple, independent treatment barriers,

(2) incorporating the **frequent monitoring of surrogate parameters at each step to ensure treatment processes are performing properly**, and

(3) developing and implementing rigorous response protocols (such as a formal Hazard Analysis Critical Control Point

Reliable Hazard Analysis Critical Control Point §64669.50 (c), (d), (f), (i), (j)

- Continuous performance monitoring: at least one surrogate or operational parameter that indicates when treatment is not performing as designed or integrity of the treatment has been compromised, such as:
  - **O3:TOC ratio**
  - **Online UVA**
  - **Online TOC**
  - **Continuously calculated UV dose or energy (EED in KWhr/1000gal)**
- Demonstrate treatment under normal full scale operating conditions

Addressing Chemical Peaks §64669.50 (k), (l)

- Chemicals that may pass through full advanced treatment
  - Low molecular weight + Resistant to oxidation
- 3 Components:
  - Ozone/Biological Activated Carbon
  - Continuous longitudinal mixing of the flow sufficient to attenuate a one-hour elevated concentration of a contaminant by a factor of ten. Mixing that occurs between the WWTP inlet chamber and the DPR project finished water compliance point may be used to meet this requirement.
  - Combined TOC limit:
    - TOC > 0.25 ppm → investigate peak, source control program
    - TOC > 0.5 ppm → critical limit, acute exposure threat → automatic diversion

RO Membrane and DBPs
§64669.50 (g), (h)

2016 Expert Panel: "AWTFs sometimes employ an oxidant . . . This practice can result in the formation of toxic byproducts, some of which are low molecular weight compounds that are not removed well during reverse osmosis or might remain after subsequent treatment with advanced oxidation processes."

- RO performance criteria:
  - Combined TOC > 0.1 ppm for > 24 hours → perform 5-day TTHMFP study on RO permeate
  - Combined TOC > 0.15 ppm for > 5 days → investigate integrity of RO membrane

Comprehensive Integrity Verification Program §64669.50 (c), (d), (f), (i), (j)

- The 0.15 TOC trigger is an approach to comply with the USEPA Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR)
- The USEPA Membrane Filtration Guidance Manual (MFGM), Appendix A describes a “Comprehensive Integrity Verification Program”
- The LT2ESWTR requires continuous integrity monitoring
- LT2ESWTR MF or UF membranes have an Upper Control Limit (UCL) for turbidity at 0.15 NTU, which trigger Direct Integrity Tests (pressure decay testing)
- An UCL should be applied to RO systems per MFGM

Chemical Control via Diversion §64669.50 (m)

2016 Expert Panel: "Providing the ability to divert advanced treated water that does not meet specifications"

- Automatically discontinue delivery of water to the distribution system for the following acute or potential acute exposures:
  1. The treatment train does not meet the 0.5 ppm TOC limit;
  2. The on-line monitoring instrument indicates exceedance of the nitrate MCL;
  3. The on-line monitoring instrument (if installed) indicates exceedance of the applicable drinking water standards for perchlorate or lead.

Technical, Managerial, Financial Capacity §64669.30

1. The Engineering Report must specify the cost of specific elements
   a. facilities,
   b. staffing, and
   c. support services
2. Ongoing costs must be determined for
   a. operation and maintenance costs,
   b. 20-year life-cycle costs of equipment,
   c. capital replacement costs,
   d. energy costs,
   e. personnel costs and other elements

Financial Capacity §64669.30

3. Reliable and continuing funding sources must be identified for the necessary costs. Funding shall include budget set asides for maintenance and capital replacement subject to a strategic asset management plan;

Examples include:

- UV lamp replacement
  - Typically between 10,000-15,000 hours of use, depending on manufacturer
  - Cost could be > $1,000,000 per year, depending on manufacturer and plant size
- Replacement of membranes after several years

Operator Certification §64669.35

- “(b) A DiPRRA shall designate at least one chief operator and at least one shift operator for each operating shift that possess valid California-Nevada Section of the American Water Works Association/California Water Environment Association advanced water treatment operator (AWTO) grade AWT5 certificate . . .”

Operations Plan §64669.80

- “(c) Prior to operation of a DPR project, a DiPRRA shall, at a minimum, demonstrate to the State Board that the personnel operating and overseeing the DPR project operations have received training in the following:
- (1) The proper operation of the treatment processes utilized pursuant to section 64669.35;
- (2) The California Safe Drinking Water Act and its implementing regulations, including the provisions of this Article;
- (3) The potential adverse health effects associated with the consumption of drinking water that does not meet California drinking water standards;
- (4) Implementation of an enhanced source control program as set forth in section 64669.40.”

Operations Plan - 2
§64669.80

- “(d) The plan must address operator certification and appropriate type and level of certification for each treatment facility associated with the DPR project.
- (e) Include a staffing plan that describes the staffing level at each treatment plant associated with the DPR project.”

- Advanced Water Treatment Operator (AWTO) is minimum expectation
- Existing WW and DW certification programs run by the state do not generally cover advance treatment processes, such as membranes, UV or ozone

Advanced Certification - AWTO

- A diverse group worked on AWTO certification program, including experts from:
  - Utilities (EBMUD, SDCWA, Encina WA, SWMOA, Padre Dam, San Diego, LA, SF, LACSD, SCVWD, Santa Barbara, Long Beach)
  - State Water Board (DDW and DFA)
  - CA Section of the Water Environment Association (CWEA)
  - CA/NV Section of the American Waterworks Association (AWWA)

AWT Operator Program

- The capability of the operator is assured via the AWTO program
- www.awtoperator.org
- From site, “Drinking water treatment, wastewater treatment or water reuse operators working at facilities using advanced water treatment technologies and related control processes may be interested in earning the new, voluntary AWT Operator (AWTO®) Certification.
- AWT Operators protect public health by ensuring a supply of safe and high-quality drinking water from advanced water reuse facilities.”

Questions?