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California Department of Public Health

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STATE OF CALIFORNIA
DIVISION OF DRINKING WATER
AND
ENVIRONMENTAL MANAGEMENT

ALTERNATIVE TREATMENT TECHNOLOGY REPORT FOR RECYCLED WATER

October 2013
(Replaces October 2012 Report)

This document has been developed to serve as a reference source for those seeking information concerning technologies that have been recognized by the California State Department of Public Health (CDPH) as being conditionally acceptable for compliance with treatment requirements of the California Water Recycling Criteria (Title 22). This is a "living" document that will be updated as needed.

Note:
The former California Department of Health Services (CDHS) became CDPH effective July 1, 2007.

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1. Introduction

The purpose of this report is to provide general reference information concerning those treatment technologies that are being utilized to meet the filtration performance and disinfection requirements for compliance with Title 22. The information contained herein was generated from a review of CDPH files and correspondence; and discussions with Field Operations Branch District Staff, SWRCB Staff, industry representatives, and manufacturers. All referenced reports, letters, and documents are on file with the CDPH Recycled Water Unit. This report may not reflect all treatment technologies in place in California, but will be updated as additional information is obtained. This report will serve as the basis for CDPH review and conditional acceptance of treatment technologies regarding compliance with the filtration and disinfection requirements of Title 22.

Title 22 (updated January 2009) defines 'filtered wastewater' and 'disinfected tertiary recycled water' as:

§60301.320. Filtered wastewater.
"Filtered wastewater" means an oxidized wastewater that meets the criteria in subsection (a) or (b):

(a) Has been coagulated* and passed through natural undisturbed soils or a bed of filter media pursuant to the following:
  (1) At a rate that does not exceed 5 gallons per minute per square foot of surface area in mono, dual or mixed media gravity, upflow or pressure filtration systems, or does not exceed 2 gallons per minute per square foot of surface area in traveling bridge automatic backwash filters; and
  (2) So that the turbidity of the filtered wastewater does not exceed any of the following:
    (A) An average of 2 NTU within a 24-hour period;
    (B) 5 NTU more than 5 percent of the time within a 24-hour period; and
    (C) 10 NTU at any time.

(b) Has been passed through a microfiltration, ultrafiltration, nanofiltration, or reverse osmosis membrane so that the turbidity of the filtered wastewater does not exceed any of the following:

  (1) 0.2 NTU more than 5 percent of the time within a 24-hour period; and
  (2) 0.5 NTU at any time.

*Note: For Title 22, Sections 60304(a) and 60307 only and except for filtration pursuant to Section 60301.320(a), coagulation need not be used as part of the treatment process provided that the filter effluent turbidity does not exceed 2 NTU, the turbidity of the influent to the filters is continuously measured, the influent turbidity does not exceed 5 NTU for more than 15 minutes and never exceeds 10 NTU, and that there is the capability to automatically activate

chemical addition or divert the wastewater should the filter influent turbidity exceed 5 NTU for more than 15 minutes.

§60301.230. Disinfected tertiary recycled water.
"Disinfected tertiary recycled water" means a filtered and subsequently disinfected wastewater that meets the following criteria:

(a) The filtered wastewater has been disinfected by either:
(1) A chlorine disinfection process following filtration that provides a CT (the product of total chlorine residual and modal contact time measured at the same point) value of not less than 450 milligram-minutes per liter at all times with a modal contact time of at least 90 minutes, based on peak dry weather design flow; or
(2) A disinfection process that, when combined with the filtration process, has been demonstrated to inactivate and/or remove 99.999 percent of the plaque forming units of F-specific bacteriophage MS2, or polio virus in the wastewater. A virus that is at least as resistant to disinfection as polio virus may be used for purposes of the demonstration.

(b) The median concentration of total coliform bacteria measured in the disinfected effluent does not exceed an MPN of 2.2 per 100 milliliters utilizing the bacteriological results of the last seven days for which analyses have been completed and the number of total coliform bacteria does not exceed an MPN of 23 per 100 milliliters in more than one sample in any 30 day period. No sample shall exceed an MPN of 240 total coliform bacteria per 100 milliliters.

CDPH considers a properly filtered and disinfected recycled water meeting the turbidity performance and coliform requirements outlined in Title 22 to be essentially pathogen free. As noted by Asano et al.[1], "To achieve efficient virus removal or inactivation in tertiary treatment, two major criteria must be met: 1) the effluent must be low in suspended solids and turbidity prior to disinfection to prevent shielding of viruses and chlorine demand, and 2) sufficient disinfectant must be applied to the wastewater."

CDPH determined the treatment requirements necessary to meet the disinfected tertiary recycled water criteria outlined in Title 22 must include media filtration or membrane filtration to reduce turbidity to less than a daily average of 2 NTU and 0.2 NTU respectively, followed by a chlorine disinfection process to ensure a minimum CT of 450 milligram-minutes per liter at all times. This treatment scheme (or an equivalent per Title 22, Section 60320.5) is intended to remove solids (including some pathogens) and properly prepare the water for effective disinfection in order to achieve an approximate 5-log reduction of virus.

[1]Asano, T.; Tchobanoglous, G.; and Cooper, R.C (1984), "Significance of Coagulation-Flocculation and Filtration Operations in Wastewater Reclamation and reuse", in Symposium Proceedings, The Future of Water Reuse, Water Reuse Symposium III, San Diego, California, August 26-31, 1984. American Waterworks Association Research Foundation.

With respect to many existing filtration technologies, there has yet to be a demonstrated correlation between turbidity and pathogen concentration. The current turbidity performance standards for media and membrane filtration are based on achievable turbidity performance and do not necessarily assure any specific minimum level of pathogen removal. This is a recognized issue in the regulations that is being reviewed by CDPH.

Since the Pomona Virus Study[2] was published, biological treatment has introduced additional variables into the picture. The type of biological treatment used can impact the particle size distribution, and downstream filter and disinfection performances. The current integration of these processes into a process train is not well understood at this time and must be addressed by industry and regulators. Nevertheless, it remains the intent of CDPH to produce an essentially pathogen free effluent by maintaining a 5-log virus removal/inactivation barrier through filtration and disinfection. Additional information concerning treatment technologies may be found in Appendix A (California Department of Health Services-Reduction of Virus and Bacteria by Filtration and Disinfection, October 2001).

2. Treatment Technology Conditional Acceptance Process

Please note that a conditionally accepted treatment technologies is not proven to work on all wastewater sources. They are known to work on some sources if designed and operated properly. Utilities are advised to pilot test the conditionally accepted treatment technologies before installation to assure the requirements of Title 22 can be met with the site specific wastewater source.

A conditionally accepted treatment technology has been evaluated and shown to comply with Title 22, Section 60320.5 on a specific wastewater source. Demonstration studies conducted using a proposed treatment technology must satisfactorily show an equal degree of treatment and reliability as those technologies listed in Title 22. Once a proposed treatment technology is listed as 'conditionally accepted', it must go through the Regional Water Quality Control Board's (RWQCB) Water Reclamation permitting process to be 'approved' for use at a specific utility. CDPH will also review and provide comments during this RWQCB permitting process to confirm full compliance with all applicable treatment and reliability features required by Title 22 for the specific treatment facility using the conditionally accepted treatment technology.

To be listed as a conditionally accepted treatment technology:

a) The manufacturer must find a suitable California utility to sponsor the proposed treatment technology.

[2]County Sanitation Districts of Los Angeles County (1977), "Pomona Virus Study, Final Report", Prepared for Calif. State Water Resources Control Board, Sacramento, Calif., and USEPA, Washington, D.C.

b) The Sponsor must agree in writing that CDPH can bill the Sponsor for time spent on the proposed treatment technology's conditional acceptance review process.

c) The manufacturer (or other party acting as their agent):
   1) Shall develop a demonstration study protocol that demonstrates the proposed treatment technology complies with Title 22, Section 60320.5. See Appendix A (Reduction of Virus and Bacteria by Filtration and Disinfection, October 2001).
   2) Submit the developed study protocol for review by the CDPH Recycled Water Unit. (This step is highly recommended, but not required.)
   3) Conduct the demonstration study.
   4) Submit a final engineering report (sometimes progress reports during testing are required), regardless of the outcome, for review by CDPH.

d) If the treatment technology is conditionally accepted, the Recycled Water Unit will notify the manufacturer in writing and add the treatment technology to this document with appropriate limitations, performance standards, and recommended permit conditions.

3. Conditionally Accepted Filtration Technology

Filters meeting the definition of "filtered wastewater" under Title 22, Section 60301.320 are allowed the option of either of the disinfection approaches outlined in Section 60301.230 without additional restrictions or requirements.

CDPH strongly recommends that when utilities consider a particular filtration technology, they carefully evaluate its appropriateness for their particular water being treated. The net production capacity of some filter technologies are especially sensitive to assumptions about how much flow can be processed per operating unit or module; assuming a flow rate that is too high can result in a filtration plant that is too small to meet system capacity requirements. Depending on the filter treatment process being employed, consideration must be given to solids loading from the secondary treatment process on the filter medium which can have a significant effect on loading/flux rate, TMP, filter run times, backwashing efficiency and other O&M and design elements. These concerns are best addressed by pilot testing the filter treatment process being considered to ensure it will meet the required treatment criteria outlined in Title 22.

Title 22, Section 60301.320 filtration performance requirements must be reliably met by all filtration technologies. CDPH strongly recommends that utilities develop and implement performance optimization plans and make reasonable effort to minimize effluent turbidity levels. Furthermore, all treatment facilities should be operated in accordance with the manufacturer's recommendations and the specific conditions required by CDPH.

The following filter technologies have demonstrated their ability to meet the performance criteria of Title 22.

a. Cloth Filters

1) Alfa Laval Ashbrook Simon-Hartley – Iso-Disc
(Formally Ashbrook)

Description: 10-micron supported by fiber reinforced plastic grid. Gravity as driving force, outside-in path.

Acceptance / References:
- Conditional acceptance letter from CDPH dated February 23, 2012.
- Report entitled "Iso-Disc Disk Filter Pilot Study Report at 69th Street Wastewater Treatment Complex" (Feb 2012).

Comments: Conditions of acceptance: loading rate not to exceed 9 gpm/ft2; Acceptance of this technology is contingent on it being complimented with a disinfection process which is compliant with Section 60301.230 (T-22); turbidity performance shall be in accordance with Section 60301.320 (a 2), and Sections 60304 (a) and 60307 (a) (Title 22); scheduled inspections of cloth conditions; ensure adequate sludge wasting.

Installations: Unknown

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2) Aqua-Aerobic Systems - MMK2-13 acrylic pile fabric

Description: Utilizing the MMK2-13 acrylic pile fabric under a vacuum.

Acceptance / References:
- Conditional acceptance letter (Corrected Copy) from CDPH dated January 13, 2009.
- Report entitled "Comparative Evaluation of the Aqua-Aerobic Systems, Inc. MMK2-13 Acrylic Pile Filter Media To Meet California's Title 22 Reuse Criteria" (April 2006).
- Both the Submerged Cloth Media Rotating Disk (AquaDisk®) and the Submerged Fixed Cloth Media (AquaDiamond®) designs are acceptable.

Comments: Utilizes the "MMK2-13 acrylic pile fabric", operates under vacuum. Conditions of acceptance: loading rate not to exceed 6 gpm/ft2; Acceptance of this technology is contingent on it being complimented with a disinfection process which is compliant with Section 60301.230 (T-22); turbidity performance shall be in accordance with Section 60301.320 (a 2), and Sections 60304 (a) and 60307 (a) (Title 22); scheduled inspections of cloth conditions; ensure adequate sludge wasting.

Installations: Unknown

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3) Aqua-Aerobic Systems - NF-102 needle felt fabric

Description: Utilizing the NF-102 needle felt fabric under a vacuum.

Acceptance / References:
- Conditional acceptance letter (Corrected Copy) from CDPH dated January 13, 2009.
- Report entitled "Evaluation of the Aqua-Aerobic Systems Cloth-Media Disk Filter (CMDF) for Wastewater Recycling Applications in California" prepared by UC Davis (March 2001).
- Report entitled "Evaluation of Aqua-Aerobics Systems AquaDisk® Filter Technology at Orange County Water District, Fountain Valley, California" (February 25, 2000).
- Both the Submerged Cloth Media Rotating Disk (AquaDisk®) and the Submerged Fixed Cloth Media (AquaDiamond®) designs are acceptable for use.

Comments: Utilizes the "102 needle felt fabric", operates under vacuum. Conditions of acceptance: loading rate not to exceed 6 gpm/ft^2; Acceptance of this technology is contingent on it being complimented with a disinfection process which is compliant with Section 60301.230 (T-22); acceptance limited to the random woven NF-102 needle felt cloth media having openings ranging from 10 to 30 microns and a thickness of 3.8 mm; turbidity performance shall be in accordance with Section 60301.320 (a 2), and Sections 60304 (a) and 60307 (a) (Title 22); Operations plan shall specify minimum FTW cycle following high pressure wash based on displacement of two filtrate volumes and effluent turbidity below 2 NTU; scheduled inspections of cloth conditions; ensure adequate sludge wasting.

Installations: Unknown

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4) Aqua-Aerobic Systems - PA-13 nylon pile fabric

Description: Utilizing the PA-13 nylon pile fabric under a vacuum.

Acceptance / References:
- Conditional acceptance letter (Corrected Copy) from CDPH dated January 13, 2009.
- Report entitled "Use of PA-13 Pile Fabric, Supplement to: Evaluation of the Aqua-Aerobic Systems Cloth-Media Disk Filter (CMDF) for Wastewater Recycling Applications in California" prepared by UC Davis (February 2002).
- Both the Submerged Cloth Media Rotating Disk (AquaDisk®) and the Submerged Fixed Cloth Media (AquaDiamond®) designs are acceptable for use.

Comments: Utilizes the "PA-13 nylon pile fabric", operates under vacuum. Conditions of acceptance: loading rate not to exceed 6 gpm/ft2; Acceptance of this technology is contingent on it being complimented with a disinfection process which is compliant with Section 60301.230 (T-22); acceptance limited to the PA-13 nylon pile fabric (as tested); turbidity performance shall be in accordance with Section 60301.320 (a 2), and Sections 60304 (a) and 60307 (a) (Title 22); scheduled inspections of cloth conditions; ensure adequate sludge wasting.

Installations: Unknown

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5) Aqua-Aerobic Systems - PES-13 woven polyester pile fabric

Description: Utilizing the PES-13 woven polyester pile fabric under a vacuum.

Acceptance / References:
- Conditional acceptance letter from CDPH dated November 14, 2007.
- Report entitled "Evaluation of the Aqua-Aerobic Systems, Inc. PES-13 Cloth Media Filter for Wastewater Reuse Applications" (September 2007).
- Both the Submerged Cloth Media Rotating Disk (AquaDisk®) and the Submerged Fixed Cloth Media (AquaDiamond®) designs are acceptable for use.

Comments: Utilizes the "PES-13 woven polyester fabric". Conditions of acceptance: loading rate not to exceed 6 gpm/ft2; Acceptance of this technology is contingent on it being complimented with a disinfection process which is compliant with Section 60301.230 (T-22); turbidity performance shall be in accordance with Section 60301.320 (a 2), and Sections 60304 (a) and 60307 (a) (Title 22); scheduled inspections of cloth conditions; ensure adequate sludge wasting.

Installations: City of Lodi

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6) Aqua-Aerobic Systems - PES-14 woven polyester pile fabric

Description: Utilizing the PES-14 microfiber woven polyester pile fabric.

Acceptance / References:
- Conditional acceptance letter from CDPH dated February 1, 2013.
- Report entitled "Evaluation of the Aqua-Aerobic Systems, Inc. OptiFiber PES-14 Cloth Medium for Wastewater Recycling Applications in California" (January 2013).

Comments: Utilizes the "PES-14 woven polyester fabric". Conditions of acceptance: loading rate not to exceed 7.0 gpm/ft2; Acceptance of this technology is contingent on it being complimented with a disinfection process which is compliant with Section 60301.230 (T-22); turbidity performance shall be in accordance with Section 60301.320 (a 2), and Sections 60304 (a) and 60307 (a) (Title 22); scheduled inspections of cloth conditions; ensure adequate sludge wasting.

Installations: unknown

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7) Entex Technologies – FlowTex Disc Filter
(Formally Parkson – DynaDisc Model 4)

Description: Submerged Cloth-Media Rotating Disk Filter utilizing the PA-13 nylon pile fabric

Acceptance / References:
- Conditional acceptance letter from CDPH dated November 5, 2007.
- Report entitled "Parkson DynaDisc™ Cloth Media Filter" dated September 27, 2007 regarding the Cloth-Media Filter.
- Conditional acceptance letter from CDPH dated September 3, 2010 regarding the Parkson DynaDisc Model 4.
- Report entitled "Parkson Corporation MBBR Package Water Treatment System" dated August 12, 2010 regarding Parkson DynaDisc Model 4 compliance with California Water Recycling criteria.
- CDPH letter dated March 7, 2011 regarding company and product name changes from Parkson Corp (DynaDisc Model 4) to Entex Technologies (FlowTex Disc Filter).

Comments: Utilizes the "PA-13 nylon pile fabric", operates under vacuum. Conditions of acceptance: loading rate not to exceed 6 gpm/ft2; Acceptance of this technology is contingent on it being complimented with a disinfection process which is compliant with Section 60301.230 (T-22); acceptance limited to the PA-13 nylon pile fabric (as tested); turbidity performance shall be in accordance with Section 60301.320 (a 2), and Sections 60304 (a) and 60307 (a) (Title 22); scheduled inspections of cloth conditions; ensure adequate sludge wasting.

Installations: Unknown

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8) Five Star Filtration – Cloth 1A-Yellow Jersey Knit Fabric

Description: Utilizing the "Cloth 1A-Yellow Jersey Knit Fabric"

Acceptance / References:
- Conditional acceptance letter from CDPH dated September 12, 2008.
- Title 22 Validation Testing Report dated August 1, 2008 submitted to CDPH.
- CDPH letter dated October 26, 2011 to raise the filter loading rate condition to 12.75 gph/ft2.
- Accompanied report titled, “Application for Title 22 Approval – Cloth 1A – Increase Flow Approval Request” (June 2011).

Comments: Utilizes the Cloth 1A-Yellow Jersey Knit Fabric (20% acrylic/80% polyester face, 100% polyester backing yarn, acrylic latex back coating) with 37.5-oz per linear yard. Conditions of acceptance: loading rate not to exceed 12.75 gpm/ft2; Acceptance of this technology is contingent on it being complimented with a disinfection process which is compliant with Section 60301.230 (T-22); turbidity performance shall be in accordance with Section 60301.320 (a 2), and Sections 60304 (a) and 60307 (a) (Title 22); scheduled inspections of cloth conditions.

Installations: Unknown

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9) Five Star Filtration – Cloth 2A-Yellow Jersey Knit Fabric

Description: Utilizing the “Cloth 2A-Yellow Jersey Knit Fabric”

Acceptance / References:
- Conditional acceptance letter from CDPH dated October 26, 2011.
- Accompanied report titled, “Application for Title 22 Approval – Cloth 2A – Approval Request” (June 2011).

Comments: Utilizes the Cloth 1A-Yellow Jersey Knit Fabric (20% acrylic/80% polyester face, 100% polyester backing yarn, acrylic latex back coating) with 63-oz per linear yard. Conditions of acceptance: loading rate not to exceed 10.35 gpm/ft2; Acceptance of this technology is contingent on it being complimented with a disinfection process which is compliant with Section 60301.230 (T-22); turbidity performance shall be in accordance with Section 60301.320 (a 2), and Sections 60304 (a) and 60307 (a) (Title 22); scheduled inspections of cloth conditions.

Installations: Unknown

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10) I. Kruger - Hydrotech

Description: Utilizing the PET mono-filament filter fabric

Acceptance / References:
- Conditional acceptance letter from CDPH dated October 2, 2003.
- Report entitled "Evaluation of the Hydrotech Filter for Compliance With Title 22 For Recycled Water Applications" prepared by Water 3 Engineering, Inc. (August 2003).

Comments: Cloth media disk or drum filter utilizing the PET mono-filament, 2:2 twill weave, 11 micron (+/-2.0) mesh opening, 523.2 (n/inch), 60 micron thickness, wt. rating of 1.48 oz./sq.yd., stabilized finish. Conditions of acceptance: loading rate not to exceed 6 gpm/ft2; Acceptance of this technology is contingent on it being complimented with a disinfection process which is compliant with Section 60301.230 (T-22); turbidity performance shall be in accordance with Section 60301.320 (a 2), and Sections 60304 (a) and 60307 (a) (Title 22); scheduled inspections of cloth conditions.

Installations: Unknown

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11) ITT Sanitaire - Drumfilter

Description: Operates as a mechanical sieve, PET, monofilament, 2.2 twill weave, nominal 21 micron pores.

Acceptance / References:
- Conditional acceptance letter from CDPH dated September 20, 2011.
- Report entitled "Drumfilter Title 22 Validation Report" prepared by Santec Consulting Services (June 2011).

Comments: Conditions of acceptance: loading rate not to exceed 12 gpm/ft2; Acceptance of this technology is contingent on it being complimented with a disinfection process which is compliant with Section 60301.230 (T-22); turbidity performance shall be in accordance with Section 60301.320 (a 2), and Sections 60304 (a) and 60307 (a) (Title 22); scheduled inspections of cloth conditions.

Installations: Unknown

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12) Nordic Water – Nordic Water Disc Filter

Description: Utilizing the Type 20/13 polyester fabric

Acceptance / References:
- Conditional acceptance letter from CDPH dated March 7, 2008.
- Report entitled "Nordic Water Disc Filter Validation Report" prepared by Eco-Logic Engineering (March 22, 2007).

Comments: Utilizes the Type 20/13 polyester fabric. Conditions of acceptance include: loading rate not to exceed 6 gpm/ft2; Acceptance of this technology is contingent on it being complimented with a disinfection process which is compliant with Section 60301.230 (T-22); turbidity performance shall be in accordance with Section 60301.320 (a 2), and Sections 60304 (a) and 60307 (a) (Title 22); scheduled inspections of cloth conditions.

Installations: Unknown

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13) Siemens Water Technologies - Forty X

Description: Disk filters utilizing the PET mono-filament filter fabric.

Acceptance / References:
- Conditional acceptance letter from CDPH dated June 3, 2008.
- Performance data report for the Forty X Disc Filter submitted to CDPH (May 2008).

Comments: Utilizes the Siemens 11/5, PET (polyester) mono-filament, 2:2 twill weave, 11 micron mesh opening, 523 (n/inch), 60 micron thickness, wt. rating of 1.5 oz./sq.yd., stabilized finish. Conditions of acceptance: loading rate not to exceed 6 gpm/ft2; Acceptance of this technology is contingent on it being complimented with a disinfection process which is compliant with Section 60301.230 (T-22); turbidity performance shall be in accordance with Section 60301.320 (a 2), and Sections 60304 (a) and 60307 (a) (Title 22); scheduled inspections of cloth conditions.

Installations: Unknown

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b. Non-Granular Media Filters

1) Amiad - AMF Wastewater Filter

Description: TC-20 thread cassette media

Acceptance / Reference:
- Conditional acceptance letter date June 8, 2009 from CDPH.
- Evaluated by Eco-Logic Engineers (Report entitled “Amiad Filtration System – AMF Wastewater Filter Final Validation Report” dated May 2009)
- Conditions of acceptance include: 1) media limited to the TC-20 design, 2) filtration rate not to exceed 2.1 gpm/ft2, 3) each cassette to be embossed

with the micron degree of filtration commensurate with the TC-20 rating, 4) required schedule of inspection of individual cassette units.

Comments:

Installations: Unknown

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2) Nova Water Technologies - Nova Ultrascreen Filter®

Description: AISI 316 steel micronic screen, 20 microns nominal size.

Acceptance / Reference:

- Conditional acceptance letter date November 12, 2009 from CDPH.
- Evaluated by Carollo Engineers (Report entitled “Title 22 Performance Testing of the Nova Water Technologies Ultrascreen® Microfilter” dated June 2008)
- Conditions of acceptance include: 1) filter screen specified as AISI 316 steel micronic screen mesh with a nominal size rating of 20 microns (down to 10 micron when using “dynamic tangential filtration”, 2) filtration rate not to exceed 6 gpm/ft2 when complimented with a disinfection process which has been demonstrated to achieve 4-log inactivation of plaque-forming units of F-specific bacteriophage MS2, or polio virus in the filtered wastewater, 3) filtration rate not to exceed 16 gpm/ft2 when complimented with a disinfection process which has been demonstrated to achieve 5-log inactivation of plaque-forming units of F-specific bacteriophage MS2, or polio virus in the filtered wastewater, 4) required schedule of inspection and assessment of the screen condition, and 5) operations plans shall provide for assurances that adequate sludge wasting is practiced to ensure against excessive solids buildup in the filter vessel.

Installations: Unknown

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3) Schreiber – Fuzzy Filter

Description: Compressible synthetic fiber filter media - upflow design. Media is quasi spherical, highly porous and compressible

Media configuration:

	Media Depth (inches)	Effective Size (")	Uniformity Coefficient
Synthetic:	30	(1.25")	1.50

Acceptance / Reference:
- Conditional acceptance letter date February 24, 2003 from CDPH.
- Conditions of acceptance include: 1) media design specs. as noted above, 2) filtration rate not to exceed 30 gpm/ft^2, 3) all Title 22 installations shall have design changes as outlined by Schreiber in correspondence dated January 21, 2003 (i.e. - backwash with filtered water, wash outlet below filtered outlet, valving position alarms), 4) individual operations plans shall include recommended operational configurations (i.e. percent compression and loading rate) based on secondary quality.
- Evaluated by U.C. Davis (Report dated September 1996)

Comments: Evaluated at loading rates up to 30 GPM/ft^2; media configuration/porosity/depth varies based on percent compression; water passes through media rather than around media.

Installations: City of Yountville

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4) Schreiber – Compressible Media Filter

Description: Also known as Fuzzy Filter. Compressible synthetic fiber filter media - upflow design. Media is quasi spherical, highly porous and compressible polyphenylene sulphide.

Media configuration:

	Media Depth (inches)	Effective Size (")	Uniformity Coefficient
Synthetic:	30	(1.5")	

Acceptance / Reference:
- Conditional acceptance letter date July 14, 2011 from CDPH.
- Conditions of acceptance include: 1) media design specs. as noted above, 2) filtration rate not to exceed 40 gpm/ft^2, 3) all Title 22 installations shall have design changes as outlined by Schreiber in correspondence dated January 21, 2003 (i.e. - backwash with filtered water, wash outlet below filtered outlet, valving position alarms), 4) individual operations plans shall include recommended operational configurations (i.e. percent compression and loading rate) based on secondary quality, 5)process controls shall confirm filter effluent and wash water valve positions with alarms.

Comments: media configuration/porosity/depth varies based on percent compression; water passes through media rather than around media.

Installations: Unknown

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c. Other Filters

1) Metawater – Ceramic Membrane
(Formerly NGK Insulators)

Description: METAWATER Co., Ltd. Ceramic Membrane Filtration System with a nominal 0.1 micron pore size. The membranes operate under positive pressure.

Acceptance / References:
- Conditional acceptance letter from CDPH dated March 7, 2007. Amendment letter dated August 19, 2008, recognizing ownership change from NGK to METAWATER.
- Report submitted by MWH, Consulting Engineers, dated October 2005, outlining study results conducted for compliance with the Surface Water Treatment Rule.

Comments: Tested on raw surface water at the Aqua De Lejos Water Treatment Plant in Upland, California. Part number for the NGK ceramic membrane tested is 431011.

Installations: Unknown

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4. Conditionally Accepted Disinfection Technology

Gaseous chlorine and hypochlorite are the most commonly used disinfectants. However alternative technologies are also recognized as being acceptable, including Ultraviolet, Ozone, and Pasteurization disinfection.

The following disinfection technologies have demonstrated their ability to meet the performance criteria of Title 22.

a. Free Chlorine Disinfection

Use of Free Chlorine is recognized as a conditionally acceptable disinfection method for meeting the inactivation criteria in Title 22 on a case-by-case basis. Pilot studies conducted in California satisfactorily demonstrated the ability of this technology to achieve greater than 5-log reduction in seeded MS2 coliphage under defined conditions.

1) San Jose Creek East WRP – Sequential Chlorination

Description: A two-step disinfection process called sequential chlorination. The process applies free chlorine and chloramines in sequence and effectively inactivates viral and bacterial target organisms while minimizing the formation of N-nitrosodimethylamine (NDMA) and trihalomethanes (THMs).

Acceptance/References:
- Conditional acceptance letter dated August 21, 2013 from CDPH.
- Report entitled "Demonstration of Sequential Chlorination for Tertiary Recycled Water Disinfection at the San Jose Creek East Water Reclamation Plant" by Sanitation Districts of Los Angeles County (April 2013).
- Acceptance of this technology includes ten (10) specific conditions to be met (as outlined in 8/21/13 letter).

Comments: This technology is only applicable to San Jose Creek East WRP.

Installations: San Jose Creek East WRP

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b. Ozone/Peroxide Disinfection

Use of Ozone (with and without hydrogen peroxide addition) is recognized as a conditionally acceptable disinfection method for meeting the inactivation criteria in Title 22. Pilot studies conducted in California satisfactorily demonstrated the ability of this technology to achieve a 6.5-log reduction in seeded MS2 coliphage under defined minimum contact time conditions.

1) APTwater - HiPOx™
(Formerly Applied Process Technology, Inc.)

Description: Ozone disinfection (with or without peroxide) - HiPOx™ System

Acceptance/References:
- Conditional acceptance letter dated December 22, 2008 from CDPH.
- Report entitled "Performance Validation of the HiPOx™ Disinfection Technology Using Ozone and Ozone/Peroxide For Reclaimed Water" by Carollo Engineers (May 2008).
- Acceptance of this technology includes nine specific conditions to be met (as outlined in 12/22/08 letter).

Comments: Pilot studies were conducted at the Dublin San Ramon Services District (DSRSD) Wastewater Treatment Plant.

Installations: City of Anaheim

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c. Pasteurization Disinfection

Use of pasteurization is recognized as a conditionally acceptable disinfection method for meeting the inactivation criteria in Title 22. Pilot studies conducted in California in 2006 and 2007 satisfactorily demonstrated the ability of this technology to achieve a minimum 4-log reduction in seeded MS2 coliphage under defined minimum contact time and temperature conditions.

1) Pasteurization Technology Group - Pasteurization System (Formerly Ryan Pasteurization and Power)

Description: Pasteurization disinfection process

Acceptance/References:

- Conditional acceptance letter dated July 25, 2007 from CDPH.
- Report entitled “RP&P Wastewater Pasteurization System Validation Report” by Carollo Engineers (July 2007).
- Conditions of acceptance include (see acceptance letter for more detail): 1) Pasteurization temperatures must ≥180 degrees F with temperature maintained continuously for a minimum of 10 seconds, 2) Upon completion of construction and prior to operation, the minimum contact time and temperature must be demonstrated to the Department, spanning a range of flow from the low flow to the high flow, with two intermediate flow points 3), For new installations, a 6-point bioassay must be performed on the pasteurization unit using seeded MS2 coliphage, 4) The accuracy and repeatability of the on-line temperature probes (thermocouples) must be demonstrated, 5) On-line monitoring of flow and temperature must be implemented in a manner similar to that documented in the July 2007 report from Carollo Engineers. The temperature throughout the cross-section of the vessel should be uniform, 6) All future proposals shall employ the operational and maintenance criteria outlined under Section 6.3 of the July 2007 report from Carollo Engineers, and 7) Ryan Pasteurization must be preceded by filters meeting the definition of "filtered wastewater" under CCR, Title 22, Section 60301.320 (a & b) or those demonstrating equivalency under Section 60320.5 ("Other Methods of Treatment") outlined in the Water Recycling Criteria. Additionally, CDPH recommends that pilot testing of pasteurization prior to design be conducted to document any impacts from a water quality that is different from the water quality documented in the July 2007 report from Carollo Engineers.

Comments: Pilot studies were conducted at the City of Santa Rosa’s Laguna Wastewater Treatment Plant.

Installations: Unknown

d. Ultraviolet Disinfection (UV)

UV Disinfection Guidelines (UV Guidelines) were first published in 1993 by the National Water Research Institute (NWRI). Since that time, the field of UV disinfection has taken great strides forward. As a result of the progress made in understanding the UV disinfection process, CDPH and NWRI agreed to revise and update the UV Guidelines. NWRI and the American Water Works Association Research Foundation (AWWARF) pooled their resources in order to revise the original UV Guidelines, which now covers water recycling and drinking water UV disinfection applications. As a result of these efforts the "Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse" was published by NWRI/AWWARF in December 2000, revised as a Second Edition dated May 2003, and later revised again as a Third Edition dated August 2012. CDPH endorses the latest August 2012 UV Guidelines and refers to them when evaluating UV disinfection proposals. One major recommendation of the UV Guidelines is that all UV equipment (including previously approved equipment) be tested and validated under the new guidelines before being conditionally accepted by CDPH. For existing systems approved under earlier guidelines, documentation of compliance with the August 2012 UV Guidelines should be provided when permits issued by the RWQCB come up for renewal. It is believed that existing UV disinfection systems that were properly designed should comply with the elements of the revised guidelines. Re-validation of such existing systems is typically performed by on-site bioassays, however alternative methods are being considered by industry. CDPH-approved testing protocols must be followed in all instances.

The implication of the recommendations contained in the 2012 UV Guidelines is that even the horizontal low-pressure low-intensity UV systems must be validated before they are conditionally accepted for a UV disinfection application. Previous conditionally accepted UV technologies that were considered to be nonconforming under the 1993 guidelines will also have to be retested using the latest recommended testing procedure. The UV technologies listed herein include a note indicating whether compliance with the most recent 2012 UV Guidelines has been demonstrated by the manufacturer.

Utilities that are in the planning or early design stages have the most flexibility and should be able to require completion of UV validation testing before they accept delivery of the UV equipment. Therefore, the utility can plan and begin the design work around a given UV system, but not allow delivery of equipment until validation testing is completed. This will allow comparison of the UV reactor design to the validation test results in order to ensure adequate sizing and performance of the UV system. This could be done as part of the design review process, i.e., while the design is not yet complete. If the design process has been completed and the contract for equipment has been signed, there will be less recourse for the utility. However, the utility can require a demonstration of performance or performance guarantee on the equipment for their own protection.

It is important to note that the UV Guidelines are only 'guidelines' and are therefore not limiting with respect to alternative approaches a manufacturer or utility may propose for consideration on a case-by-case basis. It is possible, however, that future regulations may be based on the UV Guidelines.

Appendix B is an advisory memo dated November 1, 2004 that CDPH sent to the RWQCBs in California concerning the importance of cleaning the UV quartz sleeve; the memo also outlines recommendations to help ensure effective UV disinfection.

1) Aquaray - 3X HO

Description: Horizontal lamp/low Pressure/high intensity

Acceptance:
- Acceptance granted under the outdated May 2003 NWRI Guidelines. Compliance with the latest NWRI Guidelines has not been demonstrated.
- Two conditional acceptance letters (one is a cover letter, the second is the actual acceptance letter) dated May 30, 2008.

Comments:
- Acceptance letter addresses 24 conditions (see letter for more detail).
- This system has dimensions of 0.74-m wide, 0.91-m long and 2.25 m in height, inclusive of top enclosure. There are thirty-six 160-W LPHO Amalgam lamps in a staggered six by six array oriented vertical to the flow in an open channel. An air scrub sleeve cleaning system is typically provided.
- applicable for flow rates ranging from 2 to 12 MGD at UVTs ranging from 55 to 75 percent, lamp current ranging from 2.8 to 4.5 amps, and Effective Output (EO) ranging from 0.42 to 1.00.

- Testing was performed using both granular media and membrane-filtered effluent. Two similar operating equations were developed with different constants for granular media filtration or membrane filtration.

Installations: Unknown

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2) Aquaray - 40 HO VLS

Description: Vertical lamp/low Pressure/high intensity

Acceptance:
- Acceptance granted under the outdated May 2003 NWRI Guidelines. Compliance with the latest NWRI Guidelines has not been demonstrated.
- Conditional acceptance letter dated 10/24/03 with subsequent correspondence dated 2/23/04, 4/13/04, 10/04/06 and 1/12/07.

Comments: Evaluation memo dated 4/30/97 from CDPH concerning transmittance restriction be set at >55%.

Installations: El Dorado ID, City of Petaluma, Russian River CSD, Irvine Ranch ID

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3) Aquaray - 40 VLS

Description: Vertical lamp/low Pressure/low intensity

Acceptance:
- Acceptance granted under the outdated May 2003 NWRI Guidelines. Compliance with the latest NWRI Guidelines has not been demonstrated.
- Conditional acceptance letter dated 10/24/97.

Comments: Evaluation memo dated 4/30/97 from CDPH concerning transmittance restriction be set at >55%.

Installations: Scotts Valley, Town of Windsor, Dublin/San Ramon CSD

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4) Aquionics - 400+

Description: Closed Vessel

Acceptance/Reference:
- Acceptance granted under the outdated May 2003 NWRI Guidelines. Compliance with the latest NWRI Guidelines has not been demonstrated.
- Conditional acceptance letter dated 10-15-08 from CDPH.
- Report on-file entitled "Aquionics Inc. InLine+ UV Disinfection Validation Report" by Carollo Engineers (April 2008)

Comments: Twelve conditions of acceptance outlined in the 10-15-08 acceptance letter.

Installations: Tejon Ranch, Douglas Flat/Vallecito WTP Calaveras County WD

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5) Aquionics - 16000+

Description: Closed Vessel

Acceptance/Reference:
- Acceptance granted under the outdated May 2003 NWRI Guidelines. Compliance with the latest NWRI Guidelines has not been demonstrated.
- Conditional acceptance letter dated 12-15-08 from CDPH.
- Report on-file entitled "Aquionics Inc. InLine+ UV Disinfection Validation Report" by Carollo Engineers (April 2008)

Comments: Twelve conditions of acceptance outlined in the 12-15-08 acceptance letter.

Installations: Unknown

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6) Aquionics - 18000+

Description: Closed Vessel

Acceptance/Reference:
- Acceptance granted under the outdated May 2003 NWRI Guidelines. Compliance with the latest NWRI Guidelines has not been demonstrated.
- Conditional acceptance letter dated 2-5-09 from CDPH.
- Report on-file entitled "Aquionics Inc. InLine+ UV Disinfection Systems Validation Report" by Carollo Engineers (April 2008)

Comments: Twelve conditions of acceptance outlined in the 2-5-09 acceptance letter.

Installations: Unknown

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7) Calgon – C3 500D

Description: 574-W low pressure/high output.

Acceptance/Reference:
- Acceptance granted under the outdated May 2003 NWRI Guidelines. Compliance with the latest NWRI Guidelines has not been demonstrated.
- Conditional acceptance letter dated February 13, 2012 from CDPH.
- Report entitled "Calgon Carbon C3 500 Wastewater UV Reactor Validation Report" by Carollo Engineers (January 2010)

Comments: Reactor renamed from 500 to 500D. Horizontally mounted lamps spaced at 6-inches.

Installations: Unknown

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8) NeoTec – Open Channel NOL-HM

Description: 320-W low pressure/high output.

Acceptance/Reference:
- Acceptance granted under the August 2012 NWRI Guidelines.
- Conditional acceptance letter dated September 30, 2013 from CDPH.
- Report entitled "Neotec Open Channel NOL-HM Wastewater UV Reactor Validation Report" by Carollo Engineers (Dec 2012)

Comments: Horizontally mounted lamps parallel to the flow spaced at 10cm. Has calibrated germicidal sensor. Uses dose-pacing methodology relying on UV sensor readings.

Installations: Unknown

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9) Quay Technologies - OCS 6000 Microwave

Description: Electrodeless UV lamps

Acceptance/References
- Acceptance granted under the outdated May 2003 NWRI Guidelines. Compliance with the latest NWRI Guidelines has not been demonstrated.
- Conditional acceptance letter dated June 8, 2007 from CDPH
- Report entitled “Quay Technologies, Ltd. OCS 6000 Microwave UV Validation Report” by Carollo Engineers (September 2006).

Comments: Piloted at City of Roseville. Instead of utilizing electrodes, microwave energy is generated by magnetrons and directed through wave guides into the quartz lamp sleeves containing the gas filling. The directed microwave energy excites the argon atoms, which in turn excite the mercury atoms to produce radiation.

Installations: Unknown

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10) Trojan Technologies – TojanUVFit 32AL50

Description: closed vessel, low pressure/high output.

Acceptance/References:
- Acceptance granted under the outdated May 2003 NWRI Guidelines. Compliance with the latest NWRI Guidelines has not been demonstrated.
- Conditional acceptance letter dated January 24, 2012 from CDPH.

- "Trojan Technologies, TrojanUVFit 32AL50 Validation Report", September 2009.

Comments: Ballasts adjustable from 60 to 100 percent full power. 32 lamps horizontally mounted in 20-inch closed vessel.

Installations:

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11) Trojan Technologies – TojanUVFit 72AL75

Description: closed vessel, low pressure/high output.

Acceptance/References:
- Acceptance granted under the August 2012 NWRI Guidelines.
- Conditional acceptance letter dated August 24, 2012 from CDPH.
- Report entitled "Trojan Technologies, TrojanUVFit 72AL75 Validation Report", by Carollo Engineers (November 2009).

Comments: Ballasts adjustable from 60 to 100 percent full power. 72 lamps horizontally mounted in 30-inch diameter closed vessel.

Installations: Las Galinas

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12) Trojan Technologies – UV 3000

Description: low pressure/low intensity.

Acceptance/References:
- Acceptance granted under the outdated December 2000 NWRI Guidelines. Compliance with the latest NWRI Guidelines has not been demonstrated.
- "Equivalency of the Trojan System UV4000 and System UV3000 in Meeting California Wastewater Reclamation Criteria at Pacifica, California", June 1994

Comments:

Installations: City of Escondido, Olivenhain WD

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13) Trojan Technologies – UV 3000+

Description: low pressure/high output.

Acceptance/References:

- Acceptance granted under the outdated May 2003 NWRI Guidelines. Compliance with the latest NWRI Guidelines has not been demonstrated.
- Revised conditional acceptance letter from CDPH dated July 23, 2009 for UV 3000+ (including modified end-of-lamp-life factor of 0.98). Amended October 30, 2003, October 24, 2005 (concerning lamp spacing), October 5, 2006 (concerning sleeve fouling factor of 0.95).

Comments:

Installations: LACSD Whittier Narrows, City of Fillmore, City of Roseville, City of Watsonsville, City of Soledad, City of Healdsburg, La Contenta Calaveras County WD

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14) Trojan Technologies – UV 4000

Description: medium pressure/low intensity.
Acceptance/References:

- Acceptance granted under the outdated 1993 NWRI Guidelines. Compliance with the latest NWRI Guidelines has not been demonstrated.
- Conditional acceptance letter from CDPH dated September 8, 1995 for UV4000.
- "Trojan System UV4000 UV Disinfection Pilot Study. Riverside, California", May 1995
- "Equivalency of the Trojan System UV4000 and System UV3000 in Meeting California Wastewater Reclamation Criteria at Pacifica, California", June 1994
- "Technical Review: Ultraviolet Disinfection of Wastewater to California Wastewater Reclamation Criteria (Title 22, Division 4, Chapter 3, of the California Code of Regulations) Using Trojan Technologies' System UV4000 (High Intensity UV Lamp Technology", August 1995.

Comments: Acceptance for the UV4000 conditioned on 1) continuous monitoring/recording of filter effluent turbidity (pre UV), daily coliform monitoring (disinfected effluent) and 3) provide UV dose of at least 100 mW-sec/cm2 under worst operating conditions at peak daily instantaneous flow with a minimum of three banks in operation and a UV dose of at least 140 mW-sec/cm2 with a minimum of four banks in operation, subject to all of the conditions indicated in the NWRI Guidelines.

Installations: City of San Diego (South Bay WRF), City of Pacifica, City of Santa Rosa

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15) Wedeco – LBX 90

Description: Low pressure/High Output/closed vessel

Acceptance/References
- Acceptance granted under the outdated May 2003 NWRI Guidelines. Compliance with the latest NWRI Guidelines has not been demonstrated.
- Conditional acceptance letter dated 8-21-08 from CDPH.
- Report entitled “LBX UV Disinfection System Validation Report” by Carollo Engineers (July 2008).
- Tested on potable water; therefore acceptance is limited to membrane filtered effluent per NWRI.
- This system has a 20.8-cm chamber and four 330-w LPHO lamps applicable for flow rates ranging from 0.037 to 0.432 MGD (26 to 300 GPM) at UTVs ranging from 55.6 to 77 percent, and sensor intensities ranging from 2.1 to 8.0 mW/cm2.

Comments: Acceptance letter addresses 11 conditions (see letter for more details).

Installations: Unknown

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16) Wedeco – LBX 400

Description: Low pressure/High Output/closed vessel

Acceptance/References
- Acceptance granted under the outdated May 2003 NWRI Guidelines. Compliance with the latest NWRI Guidelines has not been demonstrated.
- Conditional acceptance letter dated 8-14-08 from CDPH.
- Report entitled “LBX UV Disinfection System Validation Report” by Carollo Engineers (July 2008).
- Tested on potable water; therefore acceptance is limited to membrane filtered effluent per NWRI.
- This system has a 38.1-cm chamber and sixteen 330-w LPHO lamps applicable for flow rates ranging from 0.25 to 1.37 MGD (174 to 951 GPM) at UTVs ranging from 46 to 75 percent, and sensor intensities ranging from 2.8 to 9.2 mW/cm2.

Comments: Acceptance letter addresses 11 conditions (see letter for more details).

Installations: Unknown

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17) Wedeco – LBX 1000

Description: Low pressure/High Output/closed vessel

Acceptance/References
- Acceptance granted under the outdated May 2003 NWRI Guidelines. Compliance with the latest NWRI Guidelines has not been demonstrated.
- Conditional acceptance letter dated 12-14-07 from CDPH.
- Report entitled “LBX 1000 UV Disinfection System Validation Report” by Carollo Engineers (December 2007).

Comments:
- Acceptance letter addresses 10 conditions (see letter for more details).
- Tested on potable water; therefore acceptance is limited to membrane filtered effluent per NWRI.
- This system has a 65.5-cm chamber and forty 330-w LPHO lamps applicable for flow rates ranging from 0.58 to 3.51 MGD (403 to 2,438 GPM) at UTVs ranging from 54 to 77 percent, and sensor intensities ranging from 1.9 to 7.5 mW/cm2.

Installations: Unknown

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18) Wedeco – TAK-55 320W

Description: Low pressure/High Output/open channel

Acceptance/References
- Acceptance granted under the August 2012 NWRI Guidelines.
- Conditional acceptance letter dated Sep. 24, 2012 from CDPH.
- Report entitled “Wedeco Open Channel TAK-55 Wastewater UV Reactor 320W Validation Report”, by Carollo Engineers (January 2010).

Comments: Limited to 8.2-92.1 gpm/lamp, UVT>= 54%, and UV sensor intensities ranging from 1.42 to 4.68 mW/cm^2.

Installations: Victor Valley WRA

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19) Wedeco – TAK-55HP

Description: Low pressure/High Output/open channel

Acceptance/References
- Acceptance granted under the outdated May 2003 NWRI Guidelines. Compliance with the latest NWRI Guidelines has not been demonstrated.

- Conditional acceptance letter dated 11-24-03 from CDPH.
- Report entitled “Wedeco Ultraviolet Technologies TAK 55HP Validation Report by Carollo Engineers (October 2003).
- Revised end-of-lamp age factor for SLR 32143 HP lamp modified from 0.91 to 0.88 at 10,074 hours per letter from CDPH dated May 19, 2005.

Comments:

Installations: LACSD Lancaster, City of Lincoln

Appendix A

Recognized Filtration and Disinfection Technologies
For Recycled Water

CALIFORNIA DEPARTMENT OF HEALTH SERVICES
REDUCTION OF VIRUS AND BACTERIA BY FILTRATION AND DISINFECTION
(October 2001)

Title 22 of the California Code of Regulations (Recycled Water Criteria) requires extensive treatment of wastewater that is to be used for irrigation of parks and playgrounds or for spray irrigation of food crops. Recycled water for such irrigation is to be oxidized, filtered, and disinfected. Section 60301.320 defines filtered wastewater and Section 60301.230 defines disinfected tertiary recycled water. Additionally, Section 60320.5 allows for "other methods of treatment" provided they are found acceptable to the Department.

Treatment equivalent to that stipulated in sections 60301.320 and 60301.230 is prescribed to greatly reduce the concentration of viable enteric viruses in wastewater. Such a reduction makes it very unlikely that a person would contaminate his hands with a virus when touching a surface wet with reclaimed water. Enteric viruses are excreted by individuals with an intestinal virus infection. They can cause incapacitating disease states in susceptible persons. Those disease states include meningitis, hepatitis, and others.

Capability of Treatment that Sections 60301.320 and 60301.230 Cite

The County Sanitation Districts of Los Angeles County (CSDLAC, 1977) determined the capability of treatment that sections 60301.320 and 60301.230 cite, to reduce the concentration of viable virus in activated sludge effluent. CSDLAC added laboratory-cultured poliovirus and 150 milligrams of alum coagulant per liter of the activated sludge effluent and passed it through pilot-scale treatment facilities comprised of a clarifier and a sand filter to meet the turbidity limits that section 60301.320 cites in the definition of filtered wastewater: turbidity shall not exceed 2 turbidity units as a daily average and shall not exceed 5 turbidity units more than five percent of the time. Filter effluent was chlorinated in a chamber with a two-hour theoretical contact period and a 90-minute actual, modal contact period.

Such treatment reduced the concentration of virus plaque-forming units to 1/100,000th of the concentration in wastewater upstream from the filter, when the chlorine residual was at least 5 milligrams per liter and at least sufficient to reduce the concentration of total coliform bacteria to less than 2 per hundred milliliters. Sections 60301.320 and 60301.230 require that disinfection shall limit the concentrations of total coliform bacteria in the effluent so that the median of consecutive daily samples does not

exceed 2.2 per hundred milliliters, as determined from the bacteriological results of the last seven days for which analyses have been completed.

Equivalent Treatment by Granular Media Bed Filtration and Disinfection

Section 60320.5 of Title 22 allows the regulatory agency to accept processes other than those that Sections 60301.320 and 60301.230 cite if the applicant demonstrates to the satisfaction of DHS that the other processes will assure an equal degree of treatment. DHS deems other treatment equivalent to that cited in sections 60301.320 and 60301.230 when: (1) a proponent demonstrates that the proposed alternative treatment consistently reduces the concentration of viable virus to a level 1/100,000th of the concentration of seeded virus in influent to the filter; and (2) the proponent will provide reliability features equivalent to those that Title 22 cites, and will comply with all other applicable stipulations of Title 22.

Past demonstrations are sufficient to allow DHS to accept the combination of granular media bed filtration and disinfection of oxidized wastewater as equivalent to treatment that sections 60301.320 and 60301.230 cite, when the following four conditions are obtained:

1. coagulant is added when the turbidity of the oxidized wastewater (i.e. secondary effluent) exceeds 5 NTU for more than 15 minutes (or exceeds 10 NTU at any time) upstream from the filter;

2. the turbidity of filter effluent does not exceed a daily average of 2 NTU, 5 NTU more than 5 percent of the time, and 10 NTU at any time;

3. the concentration of viable total coliform bacteria in the final effluent does not exceed 2.2 per hundred milliliters as a median in samples taken in seven consecutive days, and does not exceed 23 per hundred milliliters in more than one sample in a 30-day period; and

4. the disinfection process complies with (a) or (b) below:

    a. if chlorination is used it provides a CT (chlorine concentration times modal contact time) value not less than 450 milligram-minutes per liter at all times with a modal contact time at least 90 minutes at the peak daily flow rate; or

    b. if ultraviolet light irradiation is used, the design and operation of the UV light disinfection process complies with the stipulations of the NWRI/AWWARF document cited below under the heading References Cited.

Demonstration with Other Filtration and Disinfection Processes

The particle size distribution (PSD) of secondary sewage treatment effluent filtered by a membrane, cloth, or similar medium will differ significantly from that of effluent of a

granular media bed filter, insofar as PSD affects the effectiveness of the downstream disinfection process. The term “size distribution” refers to the number of particles per milliliter in each of several specific ranges of sizes. Polycarbonate membrane laboratory filters with pore sizes of 12, 8, 5, 3, 1, and 0.1 micron can be used (Levine, et al., 1985; NCC, 1984), with minimal equipment requirements. A particle counter can be used to determine PSD for the following size ranges, in microns: 1.2 to 2, 2 to 5, 5 to 10, 10 to 20, 20 to 50, 50 to 100, 100 to 200, and larger than 200 (Stahl et al., 1994).

If a filter other than a granular media bed filter is proposed to be used and the use of reclaimed water requires equivalence with treatment that section 60301.320 or 60301.230 cites, the proponent must undertake a demonstration to show DHS what operating conditions guarantee that the filter and disinfection process will consistently reduce the concentration of virus to 1/100,000th of the virus concentration in wastewater upstream from the filter and limit the concentration of total coliform bacteria to comply with concentrations that sections 60303 and 60313(b) cite. The demonstration will involve operation of the filter and disinfection process under the following conditions:

- the filter receives the type of wastewater from which recycled water is proposed to be produced;
- the range of qualities of wastewater received by the filter includes qualities that are expected to occur when recycled water is produced, and are the most challenging to the effectiveness of the filter and disinfection process (e.g., concentration of suspended solids is at the maximum);
- laboratory-grown viruses are added to the wastewater upstream from the filter;
- samples are taken upstream from the filter and downstream from the disinfection process for determination of numbers of plaque-forming units of virus per volume of sample;
- samples are taken of wastewater upstream and immediately downstream from the filter for determination of concentration of total suspended solids;
- turbidity of the filter effluent is continuously measured by a continuous recording turbidimeter;
- samples of disinfected effluent are taken for determination of the concentration of total coliform bacteria;
- additionally if disinfection is by chlorination, samples are taken of wastewater upstream from the filter for determination of concentration of ammonia and samples of disinfected effluent are taken for determination of concentration of chlorine residual;

- additionally if disinfection is by UV irradiation, fluid transmittance at 254 nm (% T) and flow rate of filter effluent are continuously measured and recorded;

- The greatest appropriate time between backwashes, or other actions that renew filter yield or efficacy, is determined by experiment, with turbidity of filter effluent allowed to range as high as needed for economically practicable treatment (but not to exceed 2 NTU as a daily average, 5 NTU more than 5 percent of the time, or 10 NTU at any time); and

A test run is comprised of one continuous operation between two consecutive backwashes (or other actions that renew filter yield or efficacy). A demonstration shall have at least three test runs during which the quality and/or flow rate of influent to the filter is most challenging for the disinfection process.

Qualities most challenging to UV disinfection might include high concentration of suspended solids, high turbidity and low transmittance. Qualities most challenging to chlorine disinfection might include high concentration of suspended solids, high turbidity and high chlorine demand.

If the proponent wants to propose a CT value or minimum chlorine contact time that differs from that cited above under the heading Equivalent Treatment By Granular Media Bed Filtration and Disinfection, or a UV dose that differs from what the NWRI/AWWARF Guidelines cite, the proponent shall perform as many test runs as necessary to construct a dose-response curve for virus reduction. The curve shall show the required value(s) of such parameters at which the concentration of viable viruses in the disinfected effluent is reduced to 1/100,000TH of the concentration in the influent to the filter.

During each test run, viruses shall be added to wastewater in numbers sufficient to determine whether the concentration in disinfected effluent is less than 1/100,000th of the concentration in wastewater upstream from the filter. The viruses added to wastewater upstream from the filter shall be F-specific bacteriophage MS2, polio virus, or other virus that is at least as resistant to disinfection as polio virus. F-specific bacteriophage MS2 is a strain of a specific type of virus that infects coliform bacteria that is traceable to the American Type Culture Collection (ATCC 15597B1) and is grown on lawns of E. coli (ATCC 15597). Chlorine residual in samples of chlorinated effluent taken for determination of concentrations of virus plaque-forming units and total coliform bacteria shall be neutralized with a reducing agent approved by DHS, when those samples are taken.

The proponent shall submit to DHS a proposed protocol for all work to be undertaken in the demonstration. The proponent will undertake the demonstration only pursuant to a protocol DHS has approved.

The demonstration must identify operating conditions that consistently achieve that virus reduction and compliance with the above-cited limits on the concentration of total

coliform bacteria. The regulatory agency will cite those operating conditions and will stipulate that they will be maintained.

The combination of a filtration process and a separate disinfection process provides multiple barriers to limit the concentration of viable viruses somewhat when the other malfunctions. DHS will not accept filtration alone, or disinfection alone, as complying with Title 22.

References Cited

Levine, A.D., Tchobanoglous, G., and Asano, T., "Characterization of the Size Distribution of Contaminants in Wastewater: Treatment and Reuse Implications," Journal Water Pollution Control Federation, July 1985, pages 805-816.

NCC (Nuclepore Corporation Catalog), "Innovations in Membrane Filtration," Pleasanton, California, 1984.

National Water Research Institute / American Waterworks Association Research Foundation), Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse, December 2000. That document is available for purchase from National Water Research Institute, P.O. Box 20865, Fountain Valley, CA 92728-0865, telephone (714) 378-3278.

Stahl, J.F., Kuo, J.F., Chen, C., and Horvath, R.W., "Evaluation of Four Different Tertiary Filtration Plants for Turbidity Control", presented at 65th Annual Conference of Water Environment Federation, September 20-24, 1992, New Orleans (paper published in November/December 1994 issue of the Journal of the Water Environment Federation).

Appendix B

State of California **Department of Health Services**

Memorandum

Date: November 1, 2004

To: Regional Water Quality Control Board's Executive Officers

From: David P. Spath, Ph.D., P.E., Chief
Division of Drinking Water and
Environmental Management
1616 Capitol Avenue, MS 7400
449-5577

Subject: Cleaning of UV Quartz Sleeves

In recent years the use of ultraviolet (UV) radiation for disinfection of recycled water has increased significantly. As a relatively new technology for wastewater disinfection the Department of Health Services has been attempting to learn more about the operation of these UV facilities at recycled water plants. It has recently come to our attention that at some recycled water plants these UV facilities may be operated in a manner that could significantly compromise the disinfection treatment barrier. Specifically, we have been advised that these recycled water plants are following the practice of using the detection of coliform organisms in the treated effluent as a basis for determining how frequently to clean the quartz sleeves that protect the UV lamps. As the appropriate regulatory agency we are requesting that the Regional Water Quality Control Boards (RWQCB) look into this situation. In addition, we are recommending that the RWQCBs establish a more conservative set of requirements for all recycled water plants practicing UV disinfection to ensure that an appropriate disinfection treatment barrier is achieved. The following provides a brief discussion of the issue including background information, the problem that exists and our recommended requirements.

Background

Cleaning the quartz sleeves of a UV system is critical to ensuring the proper functioning of a UV system. Because the UV lamp is surrounded by a quartz sleeve, any coating on the surface of the quartz sleeve will reduce the transmission of UV into the wastewater thereby reducing the quantity of UV reaching or penetrating the wastewater for the purpose of disinfection. Unless this reduction in UV transmission is compensated for in the design and operation of the UV facility, the UV disinfection barrier can and will be reduced (compromised) concomitantly, i.e., the amount of disinfection being delivered will not be sufficient to meet minimum dose delivery requirement.

The National Water Research Institute (NWRI)/American Water Works Association Research Foundation (AWWARF) UV disinfection guidelines recognize this issue and recommend a 0.8 sleeve fouling factor be used in the design of UV systems. This increases the minimum dose delivery requirement in a linear manner, increasing the number of lamps required to achieve the minimum delivered dose during operation with the realization that quartz sleeve fouling is a never ending process.

Unless the UV system is operated using a sensor on the outside of a quartz sleeve for controlling the delivered dose, one does not know when or how much of an impact fouling has on UV dose delivery. Therefore, the delivered dose requirement is increased by the quartz sleeve-fouling factor to account for quartz sleeve fouling over time. While this accounts for quartz sleeve fouling in the design of the system, this approach assumes the quartz sleeve never exceeds a level of fouling that would reduce the UV dose delivery by 20 percent at any time. Such an approach is fine as long as the UV transmission through the quartz sleeve is not reduced by more than 20 percent. Unfortunately in actual operation, unless the quartz sleeve fouling rate has been established, one does not know when the limits of this fouling factor have been exceeded.

What the NWRI/AWWARF guidelines do not establish is the frequency with which the quartz sleeves should be cleaned to remove any scale or film that has been deposited on the sleeve. This is not a deficiency of the guidelines, but a reflection of inexact science and incomplete understanding of the nature of quartz sleeve fouling.

Problem

The problem that has resulted is that some water recycling plants may be using the presence of coliform organisms in the treated effluent as an indicator to determine when the quartz sleeves should be cleaned. In our opinion this is problematic. The recycled water coliform limit for filtered secondary effluent was established at a time when chlorination was used almost exclusively to provide disinfection. This limit along with requirements for total chlorine residual and contact time was established to ensure effective inactivation of viral pathogens. UV radiation, while very effective at inactivating coliform bacteria, is a much less effective viricide than chlorine. Therefore, the quantity of UV needed to meet the coliform discharge limits of less than 2.2/100mL is significantly less than the minimum dose delivery to inactivate viruses, as required in the NWRI/AWWARF UV Disinfection Guidelines.

The guidelines call for a minimum UV dose delivery requirement of 100 mJ/cm2 for standard media filtered secondary effluents. Typical coliform concentrations in media filtered secondary effluents run about 104-106 MPN/100mL. The minimum UV delivered dose needed to achieve a 4 to 6 log reduction of coliforms is about 10-20 mJ/cm2. Since 4 to 6 logs of inactivation should reduce the coliforms to nondetectable levels, this means that if coliforms are being detected the dose delivery in the system is probably around 10-20 mJ/cm2 which is 5 to 10 times below the minimum dose delivery recommended by the UV guidelines as the minimum needed for an effective disinfection barrier.

Recommended Requirements

Based on the preceding discussion we are recommending the following requirements be established by the RWQCBs:

Include a provision in permits for water recycling treatment plants employing UV disinfection that requires the water recycling plant operator to establish quartz sleeve cleaning frequencies that ensure the minimum required UV dose delivery is consistently met.

Include a provision in water-recycling permits that requires water recycling plant operators use a fixed cleaning frequency to define the quartz sleeve cleaning intervals, and not use the presence of coliform organisms in the treated effluent as a factor to determine cleaning intervals. Because the water quality parameters for establishing fouling rates are not known and because of the site-to-site variability in wastewater quality, the Department further recommends that such cleaning frequencies be established on a site-specific basis.

Include a provision in water-recycling permits that specifies the minimum delivered UV dose that must be maintained (as recommended by the NWRI/AWWARF UV Disinfection Guidelines), in addition to the coliform standard.

If you have any questions concerning this matter, please contact Dr. Rick Sakaji with this Department at (510) 849-5050.

Appendix C. Historic Conditionally Accepted Granular Media Filters

Table of Contents for Appendix C.

Granular Media Filters

Granular Media Filters

1) Andritz Ruthner, Inc. - Hydrasand

Description: Upflow, continuous wash filter

Media configuration:

	Media Depth (inches)	Effective Size (mm)	Uniformity Coefficient
silica sand:	40	1.3	1.5

Acceptance / References:
- Conditional acceptance letter dated June 23, 2000 from CDPH.
- Conditions of acceptance include: 1) media design specs. as noted above, 2) complete recycling of filter medium every three to four hours.
- Report available entitled “Microbial Assessment of the Lanai Auxiliary Reclamation Facility to Produce Wastewater Effluent for Unrestricted, Non-potable Reuse” dated October 1998.

Comments: Manufacturer has indicated they will warrant the Hydrasand Filter to meet Title 22 requirements. Same principle as the Parkson DynaSand.

Installations: None in California (proposed for City of Corona), installed in Trumansburg NY and Lanai City, HI.

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2) Applied Process Technology - Centra-flo Downflow

Description: Gravity Sand Filter Downflow Continuous Wash Filter

Media configuration:

	Media Depth (inches)	Effective Size (mm) (graded)	Uniformity Coefficient
sand:	40	0.5 – 3.0	1.50

Acceptance:
- CDPH letter dated January 6, 1999 for landscape irrigation

Comments: Pilot testing conducted at Union Sanitary District's Alvarado WWTP (1994); loading rate up to 4.4 GPM/ft2.

Installations: Tejon Ranch Development ‘99 (I-5 @ Tejon Pass)

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3) Aqua-Aerobic Systems - Automatic backwash filter (AquaABF)

Description: Shallow bed traveling bridge

Media configuration:

	Media Depth (inches)	Effective Size (mm)	Uniformity Coefficient
sand:	11	0.55	1.50

Acceptance / Reference:
- Listed in the CDPH Direct Filtration Guidelines (1988)
- U.C. Davis Evaluation Report entitled "Evaluation of the Aqua-Aerobic Automatic Backwash Filter For Wastewater Reclamation in California" dated July 1986.

Comments: Loading rate limited to 2 gpm/ft2; Max. influent turbidity <10 NTU.

Installations: Unknown

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4) Alfa Laval Ashbrook Simon-Hartley - Strata-Sand
(Formally Ashbrook Corporation)

Description: Gravity Sand Filter, Downflow Continuous Wash Filter

Media configuration:

	Media Depth (inches)	Effective Size (mm) (graded)	Uniformity Coefficient
sand:	40	multi-	AWWA B-100

Acceptance:
- Conditional acceptance letter dated July 29, 2003 from CDPH.

Comments: Performance report submitted dated June 11, 2003.

Installations: City of Oceanside (San Luis Rey WWTP)

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5) Blue Water Technology - Centra-flo Upflow
(Formally Applied Process Technology, Inc.)

Description: Upflow deep bed continuous backwash

Media configuration:

	Media Depth (inches)	Effective Size (mm)	Uniformity Coefficient
sand:	40	0.92-0.95	1.50

Acceptance / Reference:
- Conditional acceptance letter dated 3/14/2006 from CDPH.
- Conditions of acceptance include: 1) media design specs. as noted above, 2) complete recycling of filter media every three to four hours.
- Company name change in letter dated June 15, 2011. From Applied Process Tech to Blue Water Tech.

Comments: Classified as direct filtration.

Installations: Unknown

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6) Five Star Filtration - Upflow Filter

Description: Upflow deep bed continuous backwash

Media configuration:

Media Depth (inches)	Effective Size (mm)	Uniformity Coefficient
40	0.92-0.95	1.50

Acceptance / Reference:
- Conditional acceptance letter dated 1/13/2009 from CDPH.
- Conditions of acceptance include: 1) media design specs. as noted above, 2) complete recycling of filter media every three to four hours

Comments: Classified as direct filtration.

Installations: Unknown

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7) Fluidyne Corporation - Fluidsand

Description: Upflow Continuous Backwash Filter

Media configuration:

	Media Depth (inches)	Effective Size (mm) (graded)	Uniformity Coefficient
silica sand:	40	0.8 – 1.0	1.6

Acceptance / Reference:

- Conditional acceptance letter dated 5/03/2000 from CDPH. -Conditions of acceptance include: 1) media design specs. as noted above, 2) complete recycling of filter medium every three to four hours.
- Engineering Report dated June 9, 1997 submitted by Questa Engrg. for the Canada Woods Reclamation Facility.

Comments: Classified as direct filtration. Designed for waters containing TSS up to 20 mg/l (per manufacturer); Performance data submitted by the manufacturer demonstrates this technology's ability to comply with the turbidity performance standards. Design and operation conceptually similar to Dynasand.

Installations: Tenaya Lodge located in Fish Camp (Evaluated in a "facilities Review" report by Carollo Engineers dated September 1990). Canada Woods Development ('99) in the Monterey area (without CDPH approval). Castanoa Ranch ('99) in San Mateo County.

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8) Infilco-Degremont - Automatic Backwash (ABW)

Description: shallow bed, traveling bridge

Media configuration:

	Media Depth (inches)	Effective Size (mm)	Uniformity Coefficient
sand:	11	0.55	1.50

Acceptance / Reference:

- Listed in the CDPH Direct Filtration Guidelines (1988)
- U.C. Davis Evaluation Report; "Evaluation of the Enelco ABW Automatic Backwash Filter For Wastewater Reclamation in California", dated November 1988.

Comments: Loading rate limited to 2 gpm/ft2; Max. influent turbidity <10 NTU.

Installations: Sacramento County, Sepulveda Water Reclamation, Folsom WWTP, Victor Valley WWRP, LA City-Tillman WRP, Shasta Lake WWTP, and others.

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9) ITT Water & Wastewater Leopold - elimi-NITE®

Description: Deep Bed Denitrification Granular Media Filter

Media configuration:

	Media Depth (inches)	Effective Size (mm)	Uniformity Coefficient
	72	1.8	1.4

Acceptance / Reference:
- Conditional acceptance letter dated 4/10/2009 from CDPH.
- Conditions of acceptance include: 1) media design specs. as noted above, 2) loading rate limited to 5 GPM/FT2

Comments: Mono-media granular sand; 6 foot depth; intended for direct filtration with methanol addition.

Installations: Unknown

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10) Micromedia Filtration - Cleanstream

Description: "Cleanstream" Continuous Backwash Up-flow Sand Filter

Media configuration:

	Media Depth (inches)	Effective Size (mm)	Uniformity Coefficient
silica sand:	40	0.9 – 1.3	1.5

Acceptance / References:
- Conditional acceptance letter dated September 26, 2006 from CDPH.
- Conditions of acceptance include: 1) media design specs. as noted above, 2) shall be preceded by a secondary wastewater treatment process that meets the definition of an "oxidized wastewater" in accordance with Section 60301.650.
- Performance evaluations conducted at Las Gallinas Valley Sanitary District and Santa Margarita Water District (Chiquita Water Reclamation Plant).

Comments: Same principle as the Parkson DynaSand.

Installations: Unknown

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11) Nordic Water - Continuous Sand Filter

Description: "Nordic Water Continuous Sand Filter"

Media configuration:

	Media Depth (meters)	Effective Size (mm)	Uniformity Coefficient
silica sand:	1.5	1.0 – 1.5	1.5

Acceptance / References:
- Conditional acceptance letter dated March 7, 2007 from CDPH.
- Conditions of acceptance include: 1) media design specs. as noted above, 2) Maximum loading rate of 5 GPM/FT2

Comments: Same principle as the Parkson DynaSand.

Installations: Unknown

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12) Parkson Corporation - Dynasand

Description: Upflow deep bed continuous backwash

Media configuration:

	Media Depth (inches)	Effective Size (mm)	Uniformity Coefficient
sand:	40	1.30	1.50

Acceptance / Reference:
- Listed in the CDPH Direct Filtration Guidelines (1988)
- Conditional acceptance letter dated 12/1/86 from CDPH
- Conditions of acceptance include: 1) media design specs. as noted above, 2) complete recycling of filter medium every three to four hours.
- Letter dated 4/23/97 from the San Francisco District Office to the Sewerage Agency of South Marin
- Memo dated 7/18/97 from Mike Finn (CDPH) re: two performance studies (S.F. Bureau of water Pollution Control and Sewerage Agency of South Marin)

Comments: Classified as direct filtration.

Installations: Sewerage Agency of Southern Marin (Evaluation outlined in a Pilot Test Final Report for the Agency dated June 1989); San Francisco-Bureau of Water Pollution Control has a pilot unit at the Oceanside WWTP, and others.

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13) Parkson Corporation – DynaSand EcoWash

Description: Continuous, upflow, granular media with intermittent backwash

Acceptance / Reference:
- Conditional acceptance letter dated 1/30/13 from CDPH.
- Submitted report titled, "Title 22 Performance Testing of the DynaSand EcoWash Filter" Dated January 2013.

Comments: Coagulation shall be added per Title 22, section 60301.320(a).

Installations: Unknown

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14) Siemens Water Technologies Corp. - Astrasand

Description: Upflow deep bed continuous backwash

Media configuration:

	Media Depth (meters)	Effective Size (mm)	Uniformity Coefficient
sand:	1.5	1.0-1.5	1.50

Acceptance / Reference:
- Conditional acceptance letter dated 12/5/2005 from CDPH.
- Conditions of acceptance include: 1) media design specs. as noted above, 2) complete recycling of filter media every three to four hours

Comments: Classified as direct filtration.

Installations: Unknown

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15) Siemens Water Technologies Corp. - Gravisand

Description: Shallow bed traveling bridge

Media configuration:

	Media Depth (inches)	Effective Size (mm)	Uniformity Coefficient
anthracite:	6	1.1 – 1.2	1.5
sand:	5	.55 - .65	1.5
support:	-	.8 – 1.2	1.5

Acceptance / Reference:
- Conditional acceptance letter dated 11/08/05 from CDPH.
- Conditions of acceptance include: 1) media design specs. As noted above, Loading rate limited to 2 gpm/ft2; Max. influent turbidity <10 NTU.

Comments:

Installations: Unknown

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16) Siemens Water Technologies Corp. - Hydro-Clear

Description: Shallow pulsed bed filter

Media configuration:

	Media Depth (inches)	Effective Size (mm)	Uniformity Coefficient
sand:	10-12	0.45	1.50

Acceptance / Reference:
- Listed in the CDPH Direct Filtration Guidelines (1988)
- Conditional acceptance letter dated 11/17/81 from CDPH.
- Conditions of acceptance include: 1) minimum bed depth of 10-inches of sand with E.S. of 45 mm, 4) at least 6 minutes between pulses and no more than 25 pulses per filter run.
- U.C. Davis Evaluation Report; "Evaluation of the Pulsed-Bed Filter For Wastewater Reclamation in California", 1981.

Comments: Classified as direct filtration

Installations: Moulton Niguel WD, San Luis Obispo, San Clemente, Rancho Murrieta, Fallbrook, and others.

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17) Tetra Technologies, Inc. - Tetra-Denit.

Description: Tetra Deep Bed-Denitrification Filters

Media configuration:

	Media Depth (inches)	Effective Size (mm)	Uniformity Coefficient
Silica sand:	48-72	2.2	1.35

Acceptance / Reference:
- Conditional acceptance letter signed by M. Kiado (CDPH) re: LADWP dated 3/17/92
- Letter dated 10/6/97 from Parsons Engineering Science regarding LA-Glendale Water Reclamation Plant pilot study.

Comments: Mono-media granular sand; 4-6 foot depth; intended for direct filtration with chemical addition.

Installations: City of Los Angeles (Glendale WWTP), Lake Arrowhead CSD, Padre Dam MWD, Scotts Valley WD.

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18) Volcano – Downflow Filter

Description: Continuous wash downflow sand filter

Acceptance / References:
- This filter has not yet been reviewed by CDPH.
- Documentation of CDPH approval does not exist. The Recycled Water Unit has no technical data on this process.

Comments: Future proposals for use of this filtration technology will require an acceptability assessment prior to approval.

Installations: Boulder Creek G.C. (Santa Cruz County), Sierra Heights WWTP (Santa Clarita), Carmel Valley WWTP, Shelter Cove (Humbolt)

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19) Waterlink Separations - WATERLINK SuperSand

Description: Upflow deep bed continuous backwash

Media configuration:

	Media Depth (inches)	Effective Size (mm)	Uniformity Coefficient
sand:	40	1.30	1.50

Acceptance / Reference:

- Conditional acceptance letter dated 1/14/2000 from CDPH. -Conditions of acceptance include: 1) media design specs. as noted above, 2) complete recycling of filter medium every three to four hours.
- Note: Waterlink holds the patents for the design of the filter approved as the "DynaSand" marketed by Parkson Corp. under licensing agreements. Master file contains all documentation.

Comments: Classified as direct filtration. NOTE: Waterlink was purchased by Parkson Corporation.

Installations: Proposed for Delta Diablo Sanitation District (Pittsburg, CA), Coachella Valley and Escondido.

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20) Westech Engineering - WESTECH TECHNASAND

Description: Upflow deep bed continuous backwash

Media configuration:

	Media Depth (inches)	Effective Size (mm)	Uniformity Coefficient
sand:	40	1.30	1.50

Acceptance / Reference:

- Conditional acceptance letter dated 4/5/2002 from CDPH.
- Conditions of acceptance include: 1) media design specs. as noted above, 2) complete recycling of filter medium every three to four hours.
- Manufacturer has indicated they will warrant the Technasand Filter to meet Title 22 filtration requirements. Same principle as the Parkson Dynasand. Master file contains all documentation.

Comments: Classified as direct filtration.

Installations: Proposed for Carmel Valley Ranch.

Appendix D. Historic Conditionally Accepted Membrane Filters

Table of Contents for Appendix D.

Membrane Filters

Membrane Filters

Many of the membrane filters listed below were originally approved with maximum flux rates based on studies under which performance data was generated. However, references to maximum flux rates are no longer deemed necessary since they become self-limiting from a filter run and operational perspective. If operational parameters (e.g. flux, TMP) adversely impact filtration performance from a turbidity compliance or operational perspective, process control measures will likely be necessary to reliably insure compliance.

Many earlier conditions of acceptance for membrane filters included integrity tests. It has since been determined that such testing will no longer be required as a condition of acceptance for any of the listed membrane technologies. However, CDPH still recognizes integrity testing to be a valuable diagnostic tool and recommends its use for hollow fiber membranes when deemed appropriate by operational personnel.

1) Asahi-Kasei - MUNC-620A and MUDC-620A

Description: Asahi-Microza & Water Processing Division hollow fiber polyvinylidene fluoride (PVDF) membrane/ bioreactor filtration treatment units with a nominal 0.1 micron pore size. The membranes operate under vacuum. Acceptance has been granted for the following membrane designations: MUNC-620A and MUDC-620A

Acceptance / References:

- Conditional acceptance letter from CDPH dated May 8, 2007 for the hollow fiber MUNC-620A membrane.
- Conditional acceptance letter from CDPH dated July 19, 2007 for the hollow fiber MUDC-620A membrane.
- Report “Assessing the Ability of the MicrozaTM Membrane Bioreactor to Meet Existing Water Reuse Criteria” submitted by MWH, Consulting Engineers, dated March 2007, outlining study results conducted for compliance with the Water Recycling Criteria. NOTE: This report evaluated the MUNC-620A membrane.
- Report “Assessing the Ability of the MicrozaTM (MUDC-620A Membrane Bioreactor to Meet Existing Water Reuse Criteria” submitted by MWH, Consulting Engineers, dated June 2007, outlining study results conducted for compliance with the Water Recycling Criteria. NOTE: This report evaluated the MUDC-620A membrane.

Comments: Tested using an MBR process comprised of an anoxic tank followed by an aerobic tank, followed by the submerged membrane tank.

Installations: Unknown

2) Alfa Laval Ashbrook Simon-Hartley - IMAS
(Formally Ashbrook Simon-Hartley)

Description: Ashbrook Simon-Hartley Integrated Membrane Activated Sludge (IMAS) filtration treatment unit utilizing the spiral wound (Spirasep) polyethersulfone ultrafiltration membrane module with nominal 0.05 micron pore size. The membranes operate under vacuum.

Acceptance / References:
- Conditional acceptance letter from CDPH dated January 25, 2007.
- Report submitted entitled "Pilot/Demonstration System" (undated) outlining study results conducted at Eastern Municipal Water District.

Comments: System utilizes separate biological and membrane filtration units but marketed as a package plant.

Installations: Unknown

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3) Bord na Mona Environmental Products - PuraM

Description: UF made of polyethersulfone with nominal pore size of 0.05 microns.

Acceptance / References:
- Conditional acceptance letter from CDPH dated July 29, 2011.
- Report submitted entitled "Bord na Mona PuraM Membrane Bioreactor Wastewater Reuse Technology Third Party Testing Final Report".

Comments: Flat membrane plates in cassettes vertically submerged in MBR.

Installations: Unknown

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4) DOW – SFD 2860
(Formally SFX 2860)

Description: Dow Pressurized Ultrafiltration Membrane

Acceptance / References:
- Conditional acceptance letter for the SFX 2860 module from CDPH dated September 8, 2008 for recycled water applications.
- Approved for compliance under the SWTR by letter from CDPH dated July 17, 2008.
- CDPH letter dated October 26, 2011 regarding membrane name change to SFD-2860.

Comments: Utilizes a 0.03 micron pressure driven polyvinylidene fluoride (PVDF) hollow fiber membrane.

Installations: Unknown

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5) DOW – SFX 2880

Description: Dow Pressurized Ultrafiltration Membrane

Acceptance / References:
- Conditional acceptance letter for the 2880 module from CDPH dated December 3, 2009 for the upsized SFX 2880

Comments: Utilizes a 0.03 micron pressure driven polyvinylidene fluoride (PVDF) hollow fiber membrane.

Installations: Unknown

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6) Dynatec Systems – Norit CoOMP-F4385-0625

Description: Dynatec Dynalift™ Membrane Bioreactor

Acceptance / References:
- Conditional acceptance letter from CDPH dated October 21, 2009) for recycled water applications.
- Submittal included information indicating that the Dynalift MBR system utilizes the Norit CoOMP-F4385-0625, 0.03 micron, PVDF tubular membrane which has been previously accepted by CDPH for other manufactured systems. The only difference is that the module diameter has been expanded to accommodate 355 ft2.

Comments: Utilizes a 0.03 micron tubular membrane located externally from the bioreactor. Unit operates under pressure ranging from 1.0 to 5.0 psi and a typical flux rate of 20 to 45 gallons per square foot per day.

Installations: Unknown

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7) ECONITY – ECONITY CF-series

Description: Microfiltration Membrane

Acceptance / References:
- Conditional acceptance letter from CDPH dated October 24, 2012 for recycled water applications.
- Report entitled “Assessing the Ability of the ECONITY CF-series Membrane Bioreactor to Meet California’s Title 22 Water Reuse Criteria”, prepared by MWH, and dated October 2012.

Comments: Utilizes a 0.4 micron pressure driven high density polyethylene (HDPE) hollow fiber membrane.

Installations: Unknown

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8) GE/ZENON - Cycle-Let (Thetford)

Description: Membrane (“Ultra") filtration (originally marketed as Thetford Cycle-Let); complete package unit including pretreatment, biological oxidation, membrane ultra-filtration, GAC and U.V.

Acceptance / References:
- CDPH acceptance memorandum to LARWQCB dated November 12, 1993 regarding the Water Gardens Project.
- Report entitled "Evaluation of the Thetford Cycle-Let Reclamation System's Ability to Meet Title 22”, prepared by Engineering-Science, dated August 1991.
- Report entitled "Thetford Systems Inc. Cycle-Let Wastewater Treatment and Recycling System – Water Garden Project, Santa Monica, CA" dated July 1993 prepared by CDM

Comments: Membrane approved has average pore size of .005 micron. Tested on municipal wastewater.

Installations: "Water Gardens" (Santa Monica), Sony Music Campus (Santa Monica).

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9) GE/ZENON - ZeeWeed / Zenogem 500 Series

Description: PVDF with nominal pore size 0.04 microns.

Acceptance / References:

- Conditional acceptance letter from CDPH dated August 12, 1999
- Draft Final Report “California DHS Certification Testing-for GE/ZENON (ZeeWeed) Membrane” prepared by Montgomery Watson (1/8/99).
- Final Report "Assessing the Ability of Membrane Bioreactor to Meet Existing Water Reuse Criteria (GE/ZENON Environmental, Inc.)" prepared by Montgomery Watson (March 2001).
- Letter dated February 17, 2005 from CDPH re-designated formulation of membrane to PVDF-UF (OCP).
- Email dated April 12, 2012 from CDPH allowing membrane formulation changes to include PVDF-UF (OCP, SMC, FLOw).

Comments: Includes 500a, 500b, 500c and 500d membrane systems. Tested in MBR process with high solids loading.

Installations: Unknown

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10) GE/ZENON - ZeeWeed 1000 UF

Description: Submerged Hollow Fiber Ultrafiltration Membrane

Acceptance / References:

- Conditional acceptance letter from CDPH for T-22 compliance dated October 12, 2001
- Report entitled “California Department of Health Services Certification Testing For GE/ZENON ZeeWeed 1000 Membrane”, prepared by Montgomery Watson (June 2001). This report was prepared for demonstrating compliance with the California Surface Water Treatment Rule.

Comments: Approval based on use of the hollow fiber polymer “ZeeWeed 1000 UF Membrane” with a 0.02 micron nominal pore size. Tested on raw surface water.

Installations: Unknown

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11) GE/ZENON - ZeeWeed 1000 V4

Description: vacuum driven, polyvinylidene fluoride hollow fiber with direct flow and outside-in operation.

Acceptance / References:

- Conditional acceptance letter from CDPH for recycled water use dated October 26, 2011.
- Conditional acceptance letter from CDPH for potable water use dated June 30, 2011.

Comments: Acceptance based on testing conducted for potable water usage.

Installations: Unknown

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12) GE/ZENON - ZeeWeed 1500

Description: vacuum driven, polyvinylidene fluoride hollow fiber with direct flow and outside-in operation.

Acceptance / References:
- Conditional acceptance letter from CDPH for recycled water use dated October 26, 2011.
- Conditional acceptance letter from CDPH for potable water use dated June 30, 2011.

Comments: Acceptance based on testing conducted for potable water usage.

Installations: Unknown

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13) Hytachi - HPTM

Description: Submerged flat sheet, nominal pore size of 0.1 microns. PVDF membrane on a PET nonwoven fabric.

Acceptance / References:
- Conditional acceptance letter from CDPH dated May 26, 2011.
- Report entitled “Assessing the Ability of the HPT Hitatchi Membrane Bioreactor to Meet the Existing California Water Reuse Criteria” dated May 2011.

Comments: Virus seeding showed 3.9-log reduction in seeded MS2. Housed in elements and modules for a MBR system.

Installations: Unknown

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14) Huber Technology – VRM MBR

Description: Huber Vacuum Rotation Membrane VRM® Bioreactor (MBR) utilizing the Polyethersulfone flat sheet NADIR P-150F ultrafiltration membrane with nominal pore size of 0.038 micron. Submerged membrane operates under vacuum.

Acceptance / References:
- Conditional acceptance letter from CDPH dated June 22, 2006.
- Report entitled "Assessing the Ability of the Huber Vacuum Rotation Membrane VRM® Bioreactor and Membrane Clearbox® to Meet Existing Water Reuse Criteria" prepared by Montgomery-Watson-Harza (April 2006).

Comments: Tested in MBR process with high solids loading.

Installations: Unknown

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15) Hydranautics – HYDRAcap UF

Description: Hydranautics HYDRAcap Ultrafiltration Membrane

Acceptance / References:
- Conditional acceptance letter from CDPH dated April 1, 2008
- Approved for compliance under the SWTR (letter dated October 19, 1999)

Comments: Utilizes a 0.2 micron polyethersulfone hollow fiber membrane.

Installations: Unknown

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16) Hydranautics – HYDRAsub/MRE SADF MBR

Description: Hydranautics HYDRAsub®/MRE's Sterapore SADF® MBR

Acceptance / References:
- Conditional acceptance letter from CDPH dated September 23, 2009
- Report "Assessment of the Hydrasub®/Sterapore SADF® Membrane Bioreactor to Meet Water Reuse Criteria" submitted by HDR, Consulting Engineers, dated August 2009, outlining study results conducted for compliance with the Water Recycling Criteria.

Comments: Utilizes the HSE25 0.4 micron polyvinylidene Fluoride reinforced hollow fiber membrane. MBR process is preceded by a 1-mm wedge wire screen and operates under vacuum pressure. Pilot study demonstrated the unit's ability to achieve 3-log virus removal at the 50th percentile.

Installations: Unknown

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17) Ionics, Inc. – Norit X-Flow

Description: Norit X-Flow Hollow Fiber Ultrafiltration 0.05 micron, Polyethersulfone Membrane

Acceptance / References:
- Conditional acceptance letter from CDPH dated 10/21/2003
- Approved for compliance under the SWTR based on report entitled “Draft Final Report, California Department of Health Services Certification Testing for Ionics UF Membrane” prepared by Montgomery-Watson (June 2001).
- Performance study conducted at Gwinnett County, Georgia using secondary effluent; "Membrane Pilot and Demonstration-Scale Treatment for Water Reclamation at Gwinnett County, Georgia" (CH2M HILL, 2001).

Comments: Acceptance specific to the Ionics filtration technology tested using the Norit X-Flow S225, 0.05 micron, polyethersulfone hollow fiber membrane. Tested on secondary effluent.

Installations: Unknown

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18) Koch Membrane Systems – Puron KMS-L1

Description: Koch Membrane Systems Puron™ Membrane Bioreactor (MBR) utilizing the Polyethersulfone hollow fiber KMS-L1 membrane with nominal 0.05 micron pore size. Submerged membrane operates under vacuum.

Acceptance / References:
- Conditional acceptance letter from CDPH dated May 4, 2006 and amended December 18, 2007 to allow for elongated fiber up to 2.0 meters.
- Report entitled "Assessing the Ability of the Puron™ Membrane Bioreactor to Meet Existing Water Reuse Criteria” prepared by Montgomery-Watson-Harza (March 2006).

Comments: Tested in MBR process with high solids loading.

Installations: Unknown

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19) Koch Membrane Systems – Puron SMP3

Description: Koch Membrane Systems PVDF ultrafiltration hollow nominal 0.03 micron pore size. Submerged membrane operates under vacuum. Fixed base with top ends of fibers individually sealed and move freely.

Acceptance / References:
- Conditional acceptance letter from CDPH dated February 1, 2012.
- Report entitled "Final Report of the Koch Membrane Systems PURON SMP3 Membrane Bioreactor Title-22 Demonstration Testing" prepared by Trussell Technologies (Dec 2011).

Comments:

Installations: Unknown

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20) Kruger - Neosep

Description: Flat sheet PVDF UF, average pore size of 0.08 micron. Operated under a vacuum.

Acceptance / References:
- Conditional acceptance letter from CDPH dated October 12, 2006.
- Report entitled "Assessing the Ability of the Kruger Neosep Membrane Bioreactor to Meet Existing Water Reuse Criteria" (Aug 2006).

Comments:

Installations: Unknown

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21) KUBOTA Corporation – Type 510, 515, B2-515, and H025-40

Description: Kubota Membrane Bioreactor (MBR); low pressure, 0.4 micron chlorinated polyethylene flat sheet membrane.

Acceptance / References:
- Conditional acceptance letter for the Type 510 from CDPH dated March 18, 2003, amended April 29, 2004 for higher flux rate. Acceptance of the Type 515 membrane granted by letter dated July 5, 2005. Acceptance of the RM/RW Type B2-515 granted by letter dated April 29, 2009.
- Report entitled "Assessing the Ability of the Kubota Membrane Bioreactor to Meet Existing Water Reuse Criteria" prepared by Montgomery-Watson-Harza (February 2003).
- Conditional acceptance letter for the Type 515 from CDPH dated July 5, 2005.
- Report entitled "Equivalency of The Kubota Type 515 and Type 510 Membrane Cartridges" (2005).
- CDPH letter dated February 25, 2011.

- Report entitled “Kubota Type H025-40 Membrane Module as an Alternative Filtration Technology for the Production of Recycled Water in California” dated November 15, 2010.

Comments: Tested in MBR process with high solids loading.

Installations: Unknown

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22) Litree Purifying Tech – Litree PVC UF

Description: Hollow fiber, Ultrafiltration, nominal pore size 0.01 microns.

Acceptance / References:
- Conditional acceptance letter from CDPH dated January 9, 2013.
- Report entitled "Testing of Litree PVC Membrane System for Title 22 Conditional Approval” dated December 2012.

Comments: Showed >5.0-log Total Coliform reduction. Manufactured by Hainan Litree Purifying Technology Co. based in China. Flow direction is inside-out and can be configured for cross-flow or dead-end operation.

Installations: Unknown

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23) Meurer Research – Bio-Cel UP-150

Description: Submerged flat sheet, nominal pore size 0.04 microns.

Acceptance / References:
- Conditional acceptance letter from CDPH dated May 5, 2011.
- Report entitled "Assessing the Ability of the MRI BIO-CEL Membrane Bioreactor to Meet the Existing California Water Reuse Criteria” dated April 2011.

Comments: Showed a 4.0-log MS2 reduction. Polyethersulfone membrane manufactured by Microdyn Nadir. Membrane housed in elements and cassettes located in MBR.

Installations: Unknown

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24) MITSUBISHI - MBR

Description: Mitsubishi Membrane Bioreactor (MBR) Sterapore HF 0.4 micron hollow fiber polyethylene

Acceptance / References:
- Conditional acceptance letter from CDPH dated April 23, 2001
- Report entitled "Assessing the Ability of Membrane Bioreactor to Meet Existing Water Reuse Criteria (Mitsubishi Rayon Co., Ltd.)" prepared by Montgomery-Watson (March 2001).

Comments: Tested in MBR process with high solids loading.

Installations: Unknown

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25) Norit X-Flow - SXL-225

Description: Norit XigaTM and AquaflexTM Membrane Filtration Systems with a nominal 0.025 micron pore size. The membranes operate under positive pressure.

Acceptance / References:
- Conditional acceptance letter from CDPH dated June 1, 2007. This acceptance was based on previous acceptance of this membrane (letter from CDPH dated March 14, 2006) for performance compliance under the California Surface Water Treatment Rule.

Comments: The Xiga configuration is horizontally mounted and the Aquaflex is vertically mounted. Both configurations utilize the SXL-225 hydrophilic polyethersulfone - polyvinylpyrolidine (FSFC) membrane.

Installations: Unknown

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26) Parkson Corporation – Dynalift

Description: Dynalift™ System utilizing external PVDF tubular membranes (38 PRV modules manufactured by NORIT) with a nominal pore size of 0.03 micron. The tubular membranes operates under pressure and are placed externally from the bioreactor.

Acceptance / References:
- Conditional acceptance letter from CDPH dated September 7, 2006.

- Report entitled "Assessing the Ability of the Dynalift™ Membrane Bioreactor to Meet Existing Water Reuse Criteria", utilizing the 38 PRV Modules, prepared by Montgomery-Watson-Harza (July 2006).

Comments: Tested in MBR process with high solids loading.

Installations: Unknown

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27) PALL Corporation - XUSV-5203

Description: PVDF Hollow Fiber Microza Microfiltration 0.1 micron

Acceptance / References:
- Conditional acceptance letter from CDPH dated 1/10/2000
- Approved for compliance under the SWTR based on report entitled "California Department of Health Services Certification Testing for Pall (Microza) Microfiltration Membrane" prepared by Montgomery-Watson (July 1999).
- Performance study conducted at OCWD Water Factory 21 (SLS Report 7725) "Long-Term Testing of Pall Microza 0.1 um MF System on Secondary Effluent at Water Factory 21, Fountain Valley, CA" (September 23, 1998).

Comments: Tested on secondary effluent.

Installations: Unknown

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28) PALL Corporation - USV-5203, USV-6203, UNA-620A, and UNA-620A-1

Description: Microza Microfiltration

Acceptance / References:
- Conditional acceptance letters from CDPH dated 7/19/2004.
- Approved for compliance under the SWTR.
- UNA-620A-1 conditional acceptance letter from CDPH dated 1/3/2007.

Comments: Tested on raw surface water.

Installations: Unknown

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29) SIEMENS (Memcor Products) - M10V, L10V, L20V

Description: Siemens Memcor M10V, L10V and L20V polyvinylidene fluoride (PVDF) hollow fiber membrane filtration treatment units with a nominal 0.1 micron pore size. The membranes operate under positive pressure.

Acceptance / References:
- Report submitted by MWH, Consulting Engineers, dated August 2004, outlining study results conducted for compliance with the Surface Water Treatment Rule.
- Conditional acceptance letter from CDPH dated 2/2/2007.
- L20V conditional acceptance letter from CDPH dated 4/22/2008.

Comments: Tested on raw surface water at the Aqua De Lejos Water Treatment Plant in Upland, California.

Installations: Unknown

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30) SIEMENS (Memcor Products) - S10V

Description: 0.1 micron Polyvinylidene Fluoride (PVDF) Hollow Fiber Micro-Filtration – Submerged Vacuum

Acceptance / References:
- Conditional acceptance letter from CDPH dated 1/10/2000
- Updated model numbers in letter from Siemens by letter dated August 8, 2007.

Comments: Tested on raw surface water.

Installations: Unknown

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31) SIEMENS (Memcor Product) - M10B and M10C

Description: 0.2 micron Polypropylene Hollow Fiber Micro-Filtration - Pressure Filtration

Acceptance / References:
- Conditional acceptance letter from CDPH dated 1/10/2000
- Approved under the SWTR using 0.2 micron membrane.
- Updated model numbers in letter from Siemens by letter dated August 8, 2007.
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Comments: Tested on raw surface water.

Installations: West Basin MWD, Orange County Water District, City of Livermore, Dublin/San Ramon SD

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32) SIEMENS (Memcor Products) – S10T

Description: 0.2 micron Polypropylene Hollow Fiber Micro-Filtration – Submerged/Vacuum Filtration

Acceptance / References:
- Conditional acceptance letter from CDPH dated 1/10/2000
- Updated model numbers in letter from Siemens by letter dated August 8, 2007.

Comments: Tested on raw surface water.

Installations: Unknown

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33) SIEMENS (Memcor Products) – B10R, B30R and B40N

Description: 0.1 micron Polyvinylidene Fluoride (PVDF) Hollow Fiber Micro-Filtration – SBR/Vacuum Filtration; B30R formerly U. S. Filter/Jet Tech Products-Memjettm

Acceptance / References:
- Conditional acceptance letter from CDPH dated 10/7/2002
- Conditional acceptance letter from CDPH dated 11/18/05 concerning the "B30R" module.
- Conditional acceptance letter from CDPH dated 10/29/08 concerning the "B40N" module.

Comments: Tested in MBR process with high solids loading.

Installations: Unknown

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34) Sumitomo - Poreflon® SPMW-05B10

Description: Sumitomo Poreflon® Membrane Bioreactor

Acceptance / References:
- Conditional acceptance letter from CDPH dated January 23, 2009 for recycled water applications.
- Report "Assessing the Ability of the Sumitomo Poreflon® Membrane Bioreactor to Meet Existing Water Reuse Criteria" submitted by MWH,

Consulting Engineers, dated December 2008, outlining study results conducted for compliance with the Water Recycling Criteria. NOTE: This report evaluated the Poreflon® SPMW-05B10 membrane module with polytretafluoroehtylene hollow fiber membrane.

Comments: Utilizes a 0.2 micron hollow fiber membrane.

Installations: Unknown

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35) Toray MEMBRAYtm – TMR 140

Description: Toray MEMBRAYTM Membrane Bioreactor

Acceptance / References:
- Conditional acceptance letter from CDPH dated November 14, 2008 (corrected copy dated January 7, 2009) for recycled water applications.
- Report "Assessing the Ability of the Toray MEMBRAYTM Membrane Bioreactor to Meet Existing Water Reuse Criteria" submitted by MWH, Consulting Engineers, dated October 2008, outlining study results conducted for compliance with the Water Recycling Criteria. NOTE: This report evaluated the MEMBRAYTM TMR140 PVDF/PET Non-Woven flat sheet membrane.
- Conditional acceptance letter from CDPH dated January 28, 2011 for SaniBrane MBR. Report "Sanitherm MBR Title 22 Approval" dated September 2010.

Comments: Utilizes a 0.08 submerged flat sheet membrane.

Installations: Unknown

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36) TriSep Corporation – iSEP 500-PVDF

Description: iSEP 500 ultrafiltration membrane

Acceptance / References:
- Conditional acceptance letter from CDPH dated November 14, 2012 for recycled water applications.
- Report "Ovivo stormBLOX process with the iSEP 500-PVDF ultrafiltration membrane: Demonstration testing for California recycled water applications" submitted by Trussell Technologies, dated October 2012, outlining study results conducted for compliance with the Water Recycling Criteria.

Comments: Utilizes a 0.03 micron submerged spiral-wound flat-sheet membrane.

Installations: Santa Lucia Preserve Community Services District

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37) WesTech – Clearlogic MBR

Description: WesTech Clearlogic® Membrane Bioreactor

Acceptance / References:

- Conditional acceptance letter from CDPH dated December 3, 2009) for recycled water applications.
- Report "Clearlogic MBR Validation Report" submitted by Eco-Logic Engineers, dated September 2009, outlining study results conducted for compliance with the Water Recycling Criteria. NOTE: This report evaluated the submerged Hollow Sheet™ PVDF membrane with a nominal pore size of 0.2 micron as manufactured by Alfa Laval.

Comments: MBR is preceded by a coarse screen and 2 mm perforated plate fine screen. Unit operates under gravity flow or low permeate pressure via a permeate pump.

Installations: Unknown
